

# FURUNO

## OPERATOR'S MANUAL

MARINE RADAR

MODEL FR-2020



**FURUNO ELECTRIC CO., LTD.**  
NISHINOMIYA, JAPAN

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•Your Local Agent/Dealer

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## FOREWORD

Thank you for considering and purchasing the FURUNO FR-2020 Marine Radar.

For over 40 years Furuno Electric Company has enjoyed an enviable reputation for quality and reliability throughout the world. This dedication to excellence is furthered by our extensive global network of agents and dealers.

This unit is designed and constructed to ensure the user of many years of trouble-free operation. To obtain full performance from the equipment, however, you should carefully read and follow the recommended procedures for operation and maintenance. No machine can perform its intended function unless it is operated and maintained properly.

We would appreciate feedback from you, the end-user, about whether we are achieving our purposes.

**SUPPLEMENT TO OPERATOR'S MANUAL  
FOR FR-2010, FR-2020, FR-2030S**

To meet the requirements of any Administrations and customers, two versions of these radars are available, Regular or N-type. Fundamental performance is identical but operational arrangement is different on some points as follows.

	N-type	Regular type
VRM	1 VRM	2 VRMs
EBL	1 EBL (2 EBLs when setting guard zone)	2 EBLs
Guard Zone	Outer limit 6nm, inner limit 3nm, width of guard zone fixed to 0.5nm. Free sector.	Free range and sector.
Offcenter (Shift)	The sweep origin is shifted to stern side, 50% of the range on head-up mode only.	To any position within 50% of range selected.
VRM unit	NM	NM or KM selectable with panel keys. KM can be changed to SM by internal DIP switch.
Floating EBL or offset EBL	Floating EBL - EBL origin can be maneuvered by joystick (or trackball) together with "+" cursor. - Range marker on the EBL and VRM readout are always displayed regardless of whether VRM is on or off.	Offset EBL - EBL origin can be shifted to "+" cursor position but can not be maneuvered by joystick (or trackball). - Range marker on the EBL and VRM readout are displayed only when VRM is turned on.
Compliance	Netherlands and Germany	All other countries

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## SPECIFICATIONS

The new FURUNO FR-2000 series radars are the product of many years of experience in radar design and manufacturing. These rugged but attractive radars are equally at home on a hard-working commercial vessel, or the most elegant of large pleasure yachts.

Radar echoes are displayed in high-contrast yellow orange on a bright 20" diagonal raster scan CRT. For easy viewing, background color is operator-selectable as either black for nighttime use or blue for daytime use.

Target detection is greatly enhanced by the use of innovative features such as Echo Stretch, Echo Average and the built-in Interference Rejector.

Electronic aids, such as the calculation of CPA, TCPA, Echo Plotting, plus speed, range and bearing to selected targets, give the operator the ability to assess dangerous situations quickly and accurately.

The logical arrangement of backlit tactile touchpads, rotary controls, and a joystick make the FR-2000 series radars easy and intuitive to use.

Like all FURUNO digitized radars, the FR-2000 series use Multi-level Quantization of incoming radar echoes, utilizing eight levels to produce the most detailed and accurate representation of targets possible.

### 1. SCANNER UNIT

1. Type:	Slotted Array
2. Radiator Length & Type	123cm (XN2), 200cm (XN3/XN3A), 240cm (XN4A)
3. Horizontal Beamwidth:	1.8° (XN2), 1.23° (XN3/XN3A), 0.95° (XN4A)
4. Vertical Beamwidth:	25° (XN2/3), 20° (XN3A/XN4A)
5. Sidelobe Attenuation	
within + 10° of mainlobe:	-24dB (XN2/XN3), -28dB (XN3A/XN4A)
(+ 20° for 123cm antenna)	
outside + 10° of mainlobe:	-30dB (XN2/XN3), -32dB (XN3A/XN4A)
(+ 20° for 123cm antenna)	
6. Polarization:	Horizontal
7. Antenna Rotation:	24 rpm nominal (windless load)
8. Wind Load:	Relative wind 51.5 m/s (100kts)



## 2. TRANSCEIVER UNIT

- 1. Transmitting Tube: Magnetron
- 2. Frequency and Modulation: 9410 + 30MHz, PON (X-band)
- 3. Peak Output Power: 25kW (nominal)
- 4. Pulselength & Pulse Repetition Rate:

	Range (nm)	0.25-0.5	0.75-1.5	3	6-24	48	120
S H O R T	Pulselength (us)	0.08		0.3	0.6	1.2	
	Pulse Rep. Rate† (Hz)	2200		1100	600		500
L O N G	Pulselength (us)	0.08	0.3	0.6	1.2		
	Pulse Rep. Rate† (Hz)	2200	1100	600		500	

- 5. Modulator: SCR line Type Pulse Modulator
- 6. IF: 60MHz
- 7. Tuning: Manual, with tuning marker
- 8. Receiver Front End: MIC (Microwave IC)
- 9. Bandwidth: short pulse: 28MHz long pulse: 3MHz
- 10. Duplexer: Ferrite Circulator with Limiter Diode

## 3. DISPLAY UNIT

- 1. Indication System: PPI, daylight display
- 2. Picture Tube: 20" diagonal high-resolution color CRT

3. Range:	0.25	0.5	0.75	1.5	3	6	12	24	48	120
4. Range Ring Interval:	0.05	0.1	0.25	0.25	0.5	1	2	4	8	20
5. Number of Rings:	5	5	3	6	6	6	6	6	6	6

- 6. Minimum Range: less than 25m
- 7. Display Mode: Relative Motion: Head-up, North-up†, Course-up†  
True Motion: By Video Plotter RP-2 (optional)  
† gyrocompass required
- 8. Bearing Resolution: within 2.5°
- 9. Bearing Accuracy: better than 1.0°
- 10. Range Discrimination: better than 20m on 0.25nm scale
- 11. VRM/Range Ring Accuracy: 0.8% or 7m, whichever is greater

#### 4. ENVIRONMENTAL CONDITIONS

- |                         |                                   |
|-------------------------|-----------------------------------|
| 1. Ambient Temperature: | Scanner Unit ----- -25°C to +70°C |
|                         | Display Unit ----- -15°C to +55°C |
| 2. Humidity:            | Relative Humidity 95% @ +40°C     |

#### 5. POWER REQUIREMENTS

24/32VDC, 250W (24VDC); 100/110/115VAC, 360VA (100VAC), 50-60Hz, 1ø  
(rectifier required); 220/440VAC (transformer required)

#### 6. COLOR

- |               |                                  |
|---------------|----------------------------------|
| Scanner Unit: | Munsell N9.5                     |
| Display Unit: | Panel: N3.0 newtone No.5         |
|               | Chassis: 2.5GY5/1.5 embossed T25 |

#### COMPLETE SET

No.	Name	Type	Q'ty	Wt. (kg)	Remarks
1	Scanner Unit *1	XN2-RSB-0014-017	1	35	123cm, flat
		XN3-RSB-0014-017		40	200cm, flat
		XN3A-RSB-0014-017		39	200cm, oval
		XN4A-RSB-0014-017		42	240cm, oval
2	Display Unit	RDP-063	1	65	
3	Accessories	FP03-02400	1 set		code no. 000-081-046
4	Installation Materials *2	CP03-04100	1 set		ant. cable 25m code no. 000-082-958
		CP03-04110			ant. cable 30m code no. 000-082-959
		CP03-04120			ant. cable 40m code no. 000-082-960
		CP03-04130			ant. cable 15m code no. 000-082-994
5	Spare Parts	SP03-03200	1 set		code no. 000-081-045

\*1 shipped disassembled    \*2 select one of four lengths of antenna cable;  
30m standard

ACCESSORIES      FP03-02400, Code No. 000-081-046

No.	Name	Type	Code	Q'ty	Usage
1	Dust Cover	03-027-0401	100-082-460	1	
2	Hood Assembly	03-026-1601	100-073-600	1	
3	Blind Cap	03-003-0032-0	300-303-020	4	eye bolt hole

INSTALLATION MATERIALS

Scanner Unit
--------------

No.	Name	Type	Code	Q'ty	Usage
1	Crimp-on Lug	FV2-4 blue	000-538-118	1	inner shield of sig. cable
2	Crimp-on Lug	FV1.25-L3	000-538-111	29	cores of sig. cable
3	Crimp-on Lug	320882	000-537-110	1	coax wire of sig. cable
4	Hexagon Bolt	M12x60 SUS304	000-862-191	4	mounting scanner housing
5	Hexagon Nut	M12 SUS304	000-863-112	4	
6	Flat Washer	M12 SUS304	000-864-132	4	
7	Spring Washer	M12 SUS304	000-864-263	4	
8	Seal Washer	03-001-3002-0	300-130-020	4	
9	Corrosion-proof Rubber	03-001-3001-0	300-130-010	1	
10	Grounding Wire	RW-4747	000-566-000	1	
11	Hexagon Bolt	M6x25 SUS304	000-862-180	1	earth bolt
12	Hexagon Nut	M6 SUS304	000-863-109	1	
13	Flat Washer	M6 SUS304	000-864-129	3	
14	Spring Washer	M6 SUS304	000-864-260	1	

Display Unit

No.	Name	Type	Code	Q'ty	Usage
1	Crimp-on Lug	8NK4	000-538-180	2	power cable (CVV-S 8x2C)
2	Crimp-on Lug	FV2-4 blue	000-538-118	1	
3	Crimp-on Lug	FV5.5-S3	000-538-120	4	
4	Crimp-on Lug	FV5.5-S4	000-538-121	2	power cable
5	Crimp-on Lug	FV5.5-4	000-538-123	8	gyro cable
6	Crimp-on Lug	FV2-S3.3 blue	000-538-117	2	speed log cable
7	Hexagon Nut	M3 C2700W MBNI2	000-863-204	2	power cable connection
8	Flat Washer	M3 C2600P MBNI2	000-864-104	2	
9	Spring Washer	C5192W MBNI2	000-864-204	2	

SPARE PARTS SPO3-03300, Code No. 000-081-045 (1 thru 5 standard)

No.	Name	Type	Code	Q'ty	Usage
1	Fuse	FGB0 0.5A 125VAC	000-549-060	1	TX-HV line
2	Fuse	FGB0-A 5A 125VAC	000-549-064	2	antenna motor
3	Fuse	FGB01 10A 250VAC	000-549-082	2	AC power line
4	Carbon Brush	MG120-5x6x11	000-631-716	2	scanner motor
5	L-handle Socket Wrench	M8 use, diagonal 13mm	000-830-110	1	scanner unit
6	Magnetron	M5187(F)	000-101-760	1	optional
7	Diode Limiter	S-LX5B	000-107-087	1	

## OPTION

No.	Name	Type	Code	Remarks
1	External Buzzer	OP03-21	000-030-097	
2	Gyro Converter	GC-2 †		built in display unit
3	Video Plotter	RP-2		
4	Transformer Unit	RU-1758	000-030-417	220VAC, 12kg
		RU-1803	000-030-420	440VAC, 12kg
5	Rectifier Unit	RU-3423	000-030-443	req. when 240cm radiator is used with AC spec., 16.5kg
6	Cursor Gyro ROM ††	OP03-36	008-233-480	gyro conv. required
7	Power Cable	CVV-S 8x2C 15m	000-560-634	standard length
8	Handgrip	OP03-32	008-236-010	
9	Performance Monitor	PM-30		AC power req.
10	Interswitch Unit	RJ-2/5		
11	Auto Ploter	ARP-2		built in display unit
12	Slave Display Unit	CD-140/141		radar color display unit
		FMD-800/8000		monochrome display 20kg
13	Signal Cable Assy. (RW-3839-2 cable, without armor)	S03-28-15	008-377-780	ant. cable 15m
		S03-28-25	008-377-750	ant. cable 25m
		S03-28-30	008-377-760	ant. cable 30m
		S03-28-40	008-377-770	ant. cable 40m

† An AC synchro gyrocompass having a gyro ratio of 180X cannot be interfaced with the GC-2. In this case, use A-D Converter AD-10S.

†† Cursor gyro ROM program No.0357204-1xx for replacement of system program ROM U45 on AD board 03P7030. (standard system program No.0357400-1xx without cursor gyro.)



## OPERATIONAL OVERVIEW

### GENERAL

This radar is equipped with numerous functions which help the navigator assess marine traffic conditions. These functions are, however, easy to access due to the functional and logical arrangement of the front panel controls.

If you change a control setting you will see the associated reaction almost immediately on the screen. Key operation is confirmed by a beep tone, while unacceptable key entry is communicated by a series of beep tones.

A brief explanation of the function and location of each control and the location of legends, annunciators, etc. is given on pages 21 and 22.

### BASIC OPERATION

#### TURNING THE POWER ON & TRANSMITTING THE RADAR

After having confirmed that there are no obstructions around the scanner, turn the POWER and SCANNER switches to ON. (The scanner switch is located in the sub panel. It may be permanently set to ON.) DIP switch settings, program no., the results of the self-check, total on time, total TX time, and the 3-minute timer are displayed (see Fig. 1). The 3-minute timer begins counting down from 3:00 to 0:00, whereupon it changes to "ST-BY," indicating the radar is ready to transmit.

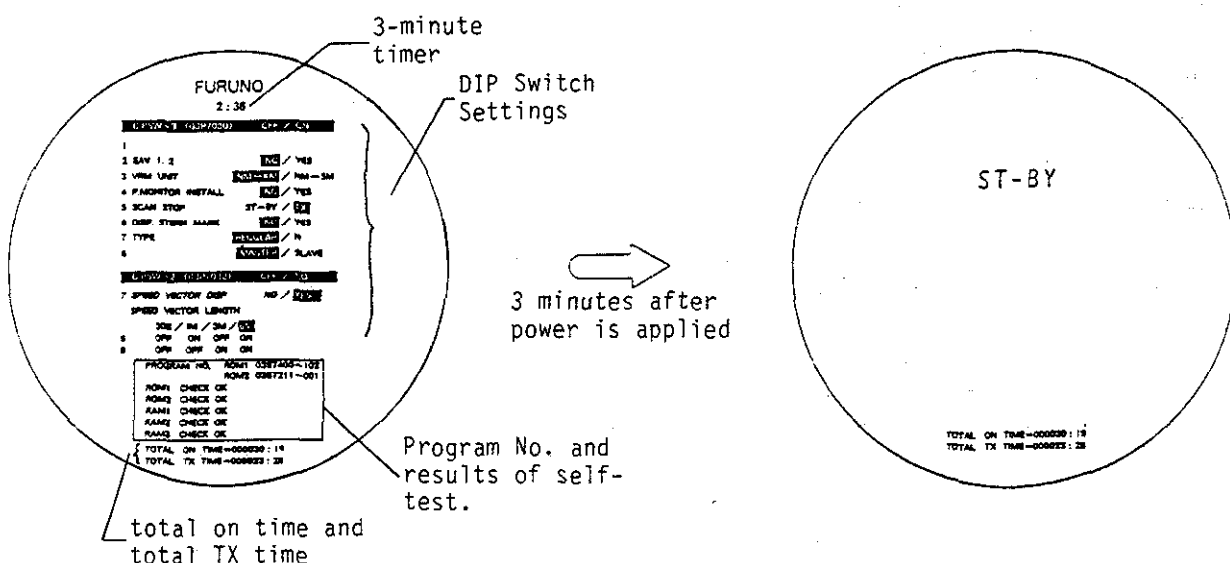


Fig. 1 Display Screen During Warm-up Period

When the message ST-BY appears on the screen, the radar may be transmitted by selecting an appropriate pulselength with the FUNCTION switch. As a general rule of thumb, use the short pulse when target discrimination is required, and use the long pulse when range is important. Shortly after a pulselength is selected the display screen lights up, and any echoes received from targets are displayed on the screen. If the FUNCTION switch is set to a pulselength setting during the 3-minute warm-up period, TX appears below the timer indication and the radar will begin transmitting immediately at 0:00.

To temporarily suspend transmission, set the FUNCTION switch to ST-BY.

## RANGE SELECTION

The RANGE touchpads ([+],[ -]) are used to select the RANGE. The range selected determines automatically the fixed range ring interval. Press the [+] touchpad to increase the range, or press the [-] touchpad to lower the range. The range selected and the range ring interval are indicated at the upper left-hand corner on the screen.

## TUNE CONTROL ADJUSTMENT

The TUNE control is used to tune the receiver. For the first 10 minutes of operation the tuning should be checked periodically because the transmitter has not stabilized yet. Readjustment after the first 10 minutes is normally not required.

Tuning is made easy by the use of the tuning bar provided at the upper right-hand side of the display screen. The TUNE control is so adjusted to display the longest tuning bar.

To tune the receiver, first turn the A/C SEA control fully counterclockwise and set the range to maximum. Turn the TUNE control between its extremes until the longest tuning bar (between 4 and 5 tuning markers) is obtained.

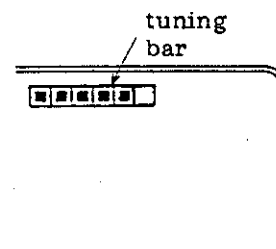


Fig. 2 Tuning Bar

## GAIN CONTROL ADJUSTMENT

The GAIN control is used to adjust the sensitivity of the receiver, and thus the strength of echoes as they appear on the screen. It is adjusted so that the speckled noise background is just visible on the CRT.

To properly set the gain, first select one of the two longest ranges--the speckled background is more apparent on long ranges. Turn the GAIN control clockwise slowly; you should be able to see the speckled background appear when the position of the control is between 2 and 3 o'clock. If you set up for too little gain, weak echoes may be missed. If you turn the control too far clockwise, yielding too much speckled noise background, targets may be missed because of the poor contrast between desired echoes and the background noise on the display.



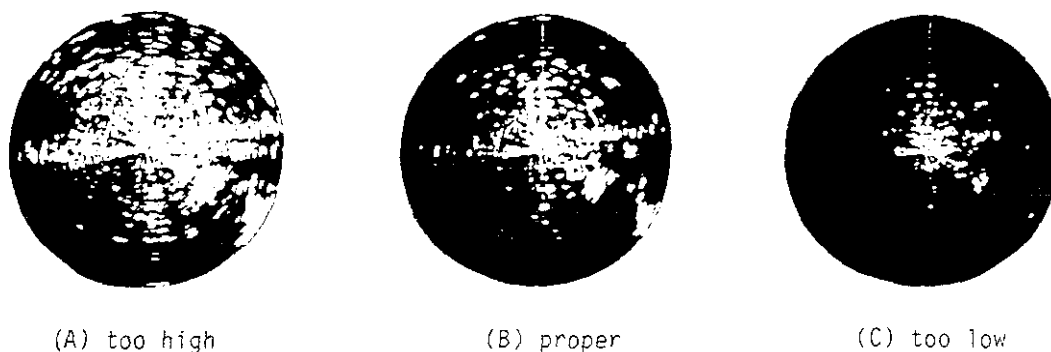


Fig. 3 Gain Control Adjustment

## ELIMINATING RETURNS FROM SEA SURFACE AND RAIN CLUTTER

### Sea Returns

Sea returns appear on the screen as a large number of small echoes (see Fig. 4) which might affect radar performance. The action of the A/C SEA circuit is to reduce the amplification of echoes at short ranges (where clutter is the greatest) and progressively increase amplification as the range increases, so that amplification will be normal at those ranges where sea clutter is not experienced. The control is effective to a maximum of about 8 miles.

The proper setting of the A/C SEA control is so that the clutter is broken up into small dots, and small targets become distinguishable. If the control is not sufficiently advanced, other targets will be hidden in the clutter, while if it is set too high, both sea clutter and targets will be erased from the screen. As a general rule of thumb, turn the control clockwise until the clutter has disappeared leeward, but a little is still visible windward. Always leave a little clutter visible on the screen, this ensures weak echoes will not be suppressed. If no clutter is visible on the screen, leave the control in the fully counterclockwise position.

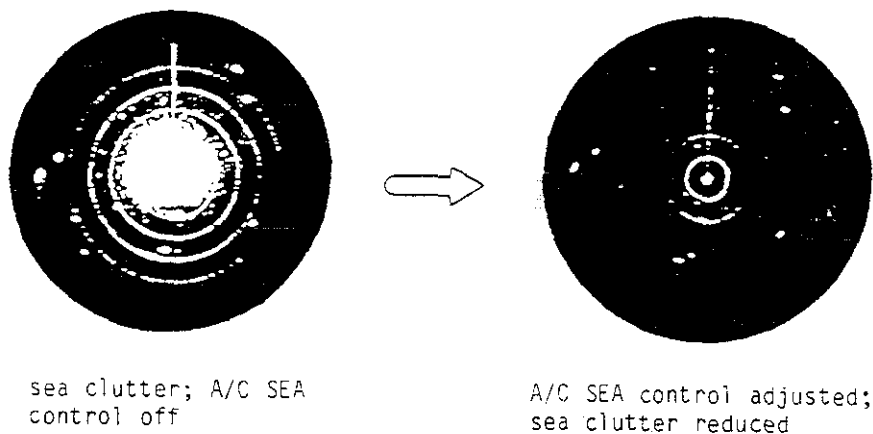


Fig. 4 Adjusting the A/C SEA Control

## Rain Clutter

The echoes of ships operating inside rain, hail, or snowstorms may be hidden by on-screen rain clutter. Rain clutter is easily recognizable by its wool-like appearance on-screen. When this type of interference obscures a large area of the screen, you can use the A/C RAIN (anti-clutter rain) control to reduce the clutter.

When the A/C RAIN control is turned clockwise receiver sensitivity is suppressed to break up the clutter into small speckles. Thus it may also be used in clear weather to separate groups of echoes on a congested short-range picture. In all cases use discretion when adjusting the control, since advancing it too far clockwise may erase targets echoes from the screen.

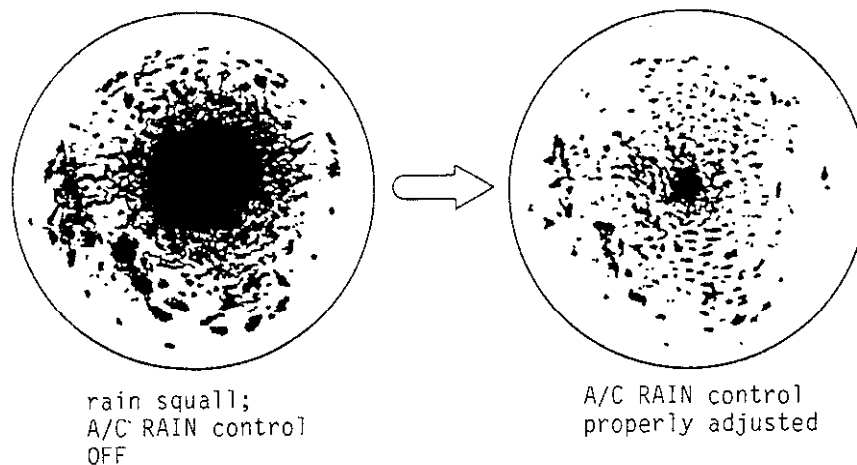


Fig. 5 Effect of the A/C RAIN Control

## Automatic Clutter Control

The [A/C AUTO] (anti-clutter auto) touchpad controls the video circuit which automatically suppresses sea and rain clutters, overriding the manual control for A/C SEA and A/C RAIN. The ON/OFF status of the circuit is indicated at the top of the screen. It is recommended to adjust the manual A/C SEA and RAIN controls also when A/C AUTO is used.

## BRILLIANCE ADJUSTMENT

Controls are provided to adjust the brilliance of the CRT, alphanumeric annunciators, legends, etc. Most brilliance controls (touchpads) are located at the left-hand side of the display unit, except for the CRT brilliance-adjusting control which is located to the right of the FUNCTION switch.

Each brilliance-adjusting touchpad provides three levels of brilliance; low, medium and high. Each time one of these touchpads is pressed the brilliance changes in the aforementioned sequence.

## CRT

The BRILLIANCE control adjusts CRT brightness. Turn it clockwise to increase the intensity of the radar echo blips. Adjust it so that radar echo blips may be observed clearly.

## Heading Mark

The [HM] touchpad may be used to adjust the brightness of the heading marker.

## Plot Symbol

The [PLOT SYMBOL] touchpad controls the brightness of the 10 plot symbols in OFF-LOW-MEDIUM-HIGH intensity levels.

## Data

The brightness of the plot data table at the upper right-hand corner of the screen, RANGE, RING, GYRO (gyro reading), and VRM and EBL readouts may be adjusted in OFF-LOW-MEDIUM-HIGH intensity levels with the [DATA] touchpad.

## Joystick

The [JOYSTICK] touchpad controls the brilliance of the cursor. Each time the touchpad is depressed the brilliance of the cursor changes in the following sequence; OFF-LOW-MEDIUM-HIGH.

## Ring

The [RING] touchpad controls the brilliance of the range rings. Each time the touchpad is pressed the brilliance of the range rings changes in the following sequence; OFF-LOW-MEDIUM-HIGH.

## Mark

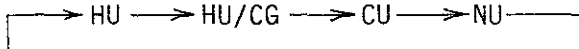
The [MARK] touchpad controls the brightness of the VRM, EBL, North Mark and Guard Zone in OFF-LOW-MEDIUM-HIGH intensity levels.

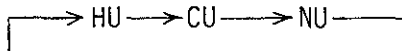
## Panel

The [PANEL DIM] touchpad may be used to adjust the brilliance of the control panels.

## PRESENTATION MODE SELECTION

The [SELECT] touchpad is used to select the presentation mode. There are either three or four modes selectable, Head-up, Head-up CG, North-up, Course-up, depending on whether the cursor gyro program is fitted or not. Each time the touchpad is pressed the mode changes in the following sequence.

with cursor gyro program ----- 

without cursor gyro program ----- 

The mode selected is indicated by "HEAD UP," "NORTH UP," or "COURSE UP" at the top left-hand side of the screen.

## Head-Up/Head-Up CG Mode

The picture is orientated so that the heading mark appears at the top of the screen. This mode is most suitable for navigation in congested areas or narrow channels. In the Head-up CG (Cursor Gyro) Mode the bearing scale rotates according to gyrocompass reading.

Note that the north mark appears only when a gyrocompass is connected.

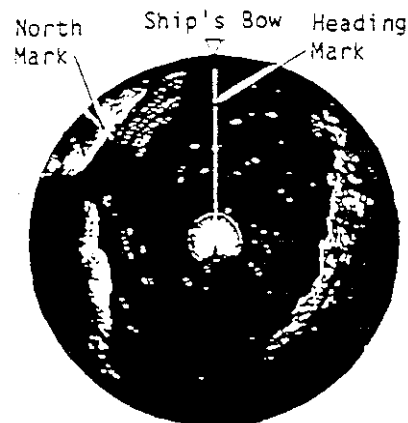


Fig. 6 Head-Up Mode Display

## Course-Up Mode †

The orientation of the picture is stabilized so that the course immediately before the Course-up is selected is fixed to the top of the screen. If you make a course change, press the [SELECT] touchpad to get the Course-up Mode. After the course change is completed, press the [RESET] touchpad if you still continue to use the Course-up Mode.

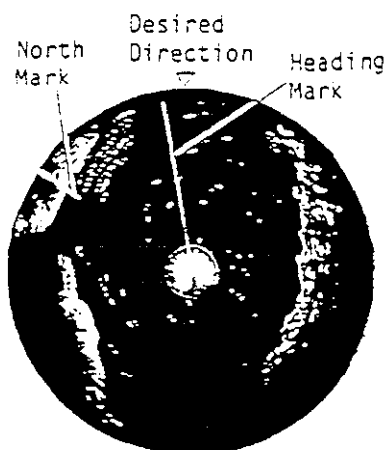


Fig. 7 Course-Up Mode Display

## North-Up Mode †

The radar picture is stabilized so that the North is at the top of the screen and the heading mark changes according to the orientation of the ship's heading. This mode is suitable for both measuring the ship's position and as a navigation monitor on a navigational chart. The picture is stabilized against yaw of the vessel, reducing the smearing of target echoes.

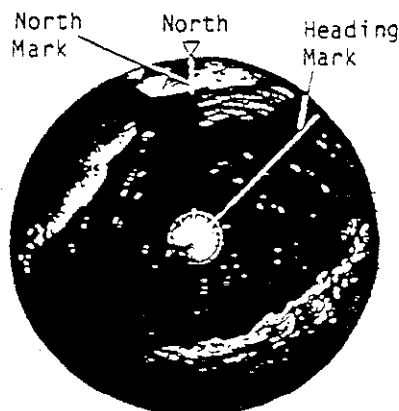


Fig. 8 North-Up Mode Display

† gyrocompass required

## Loss of Gyro Signal

When the gyro signal is lost, the presentation mode automatically becomes HEAD UP and the legend GYRO as well as the gyro readout flashes. They continue to flash even when the gyro signal is recovered to warn the operator that the readout is unreliable. If this occurs, check the on-screen gyro indication. If it is wrong, align the gyro interface (see page 17), and press the [SELECT] touchpad to stop the flashing. If you wish to select a presentation mode other than Head-up further press the [SELECT] touchpad until the desired mode is obtained.

## REDUCING RADAR INTERFERENCE

Radar interference may occur when in the vicinity of another shipborne radar operating in the same frequency band. It appears on the screen often as a large number of bright dots either scattered at random or in the form of "curved spokes" (see Fig. 9). This type of interference can be reduced by activating the Interference Rejector circuit. Press the [INT REJECT] touchpad to activate the circuit. The IR symbol appears at the screen top. Press the touchpad again to switch off the circuit when no interference exists, otherwise weak targets may be missed.

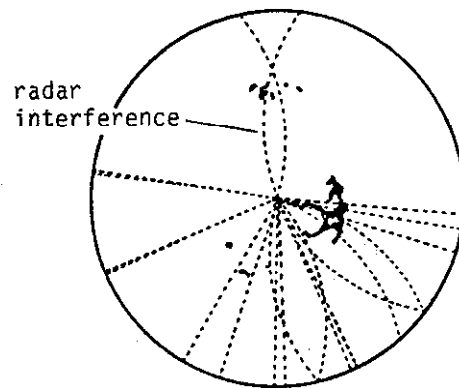


Fig. 9 Radar Interference

## ERASING THE HEADING MARK/NORTH MARK

When the radar is turned on, the heading mark is displayed. The north mark is also displayed if a gyrocompass is connected. When the heading mark or north mark masks or hinders recognition of a small target echo, press and hold the [HM OFF] touchpad to temporarily erase them. Release hold to redisplay them.

## DISPLAY COLOR SELECTION

The display color can be changed as follows by pressing the [COLOR] touchpad. Select the color scheme which best suits your needs.

Background	Alphanumerics, Marks	Bearing Scale, Range Rings	VRM/EBL
Blue	Green	White	Green
Black	White	Green	Blue

## RANGE AND BEARING MEASUREMENT

The range to a target may be measured with the range rings or a Variable Range Marker (VRM), and the bearing of a target may be measured with an Electronic Bearing Line (EBL).

Selection and operation of the VRM and EBL markers are quite simple. At each bottom corner of the display unit there is a touchpad control, EBL ON/OFF on the left corner and VRM ON/OFF on the right corner, and a rotary knob. Each rotary knob operates two markers, VRM No.1 or VRM No.2, or EBL No.1 or EBL No.2.

To display a marker, press an ON touchpad. Each time the touchpad is pressed the marker operative by the rotary knob control is circumscribed at the bottom left (EBL) or bottom right (VRM) of the screen.

When use of a marker is not required, you can erase it by pressing the associated OFF touchpad. If two like markers are displayed when the OFF touchpad is pressed, the inoperative marker is erased.

Marker differentiation is made by making the lengths of the dash on the No.1 markers shorter than those of the No.2 markers.

NOTE: For N-type version, the No.2 VRM and EBL are not provided.

### RANGE MEASUREMENT

Press the [VRM ON] touchpad to display a VRM on the screen. Next, rotate the VRM rotary knob control until the circle described by the VRM just touches the inside edge of the target blip (see Fig. 10). The range to the target is shown at the lower right-hand corner of the screen; VRM No.1 annunciator on top and VRM No.2 annunciator below it.

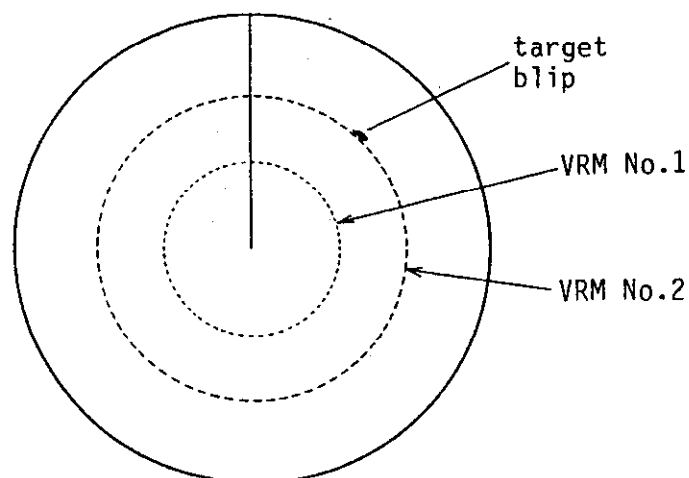


Fig. 10 Range Measurement with a VRM  
(VRM No.2 is for regular-type only)

## VRM Measurement Unit Selection (for regular-type only)

VRM readout may be displayed in either nm km or nm sm depending on the setting of an internal DIP switch (for further details, see page AP1-1.) To alternate between nm and km (or nm and sm), press the [VRM ON] touchpad while pressing and holding the [HM OFF] touchpad.

## BEARING MEASUREMENT

Press the [EBL ON] touchpad to display an EBL. Then, rotate the EBL rotary knob control until the EBL bisects the target blip (see Fig. 11). The relative bearing to the target from own ship is indicated at the lower left-hand corner of the display screen; EBL No.1 annunciator on top and EBL No.2 annunciator below it. If the radar is interfaced with a gyrocompass, true and relative bearings can be alternated by pressing the [TRU/REL] touchpad.

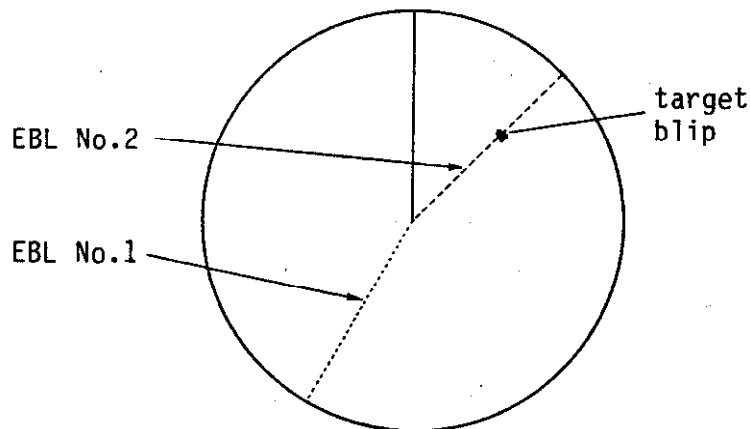


Fig. 11 Measuring Bearing With an EBL  
(EBL No.2 is for regular-type only)

## Using the Offset EBL (for regular-type version)

The origin of the EBL can be placed anywhere with the joystick (or trackball) to provide measurements of bearing and range between two targets. This function is also useful for assessing possible collision situations.

1. Press the [JOYSTICK] touchpad to display the cursor on the screen. Superimpose the cursor on the target echo desired by operating the joystick (or trackball).

## Cursor Data

The range and bearing between own ship and the intersection of the cursor may be displayed (or erased), when the cursor is displayed, at the upper left-hand side of the screen by pressing the [JS DATA] touchpad.

2. Display an EBL on the screen. Press the [OFFSET/RESET] touchpad, and the EBL origin is placed at the intersection of the cursor.
3. After waiting 3 or 6 minutes, operate the EBL rotary knob control until the EBL bisects the target. If the EBL passes through own ship's mark, the possibility of collision may exist.
4. To measure the range between two targets press the [VRM ON] touchpad to display the VRM (No.1 or No.2) associated with the active EBL. The range marker (see Fig. 12b) is superimposed on the EBL. Operate the VRM rotary knob control; the range to the other target is shown on the VRM annunciator at the lower right-hand side of the screen.

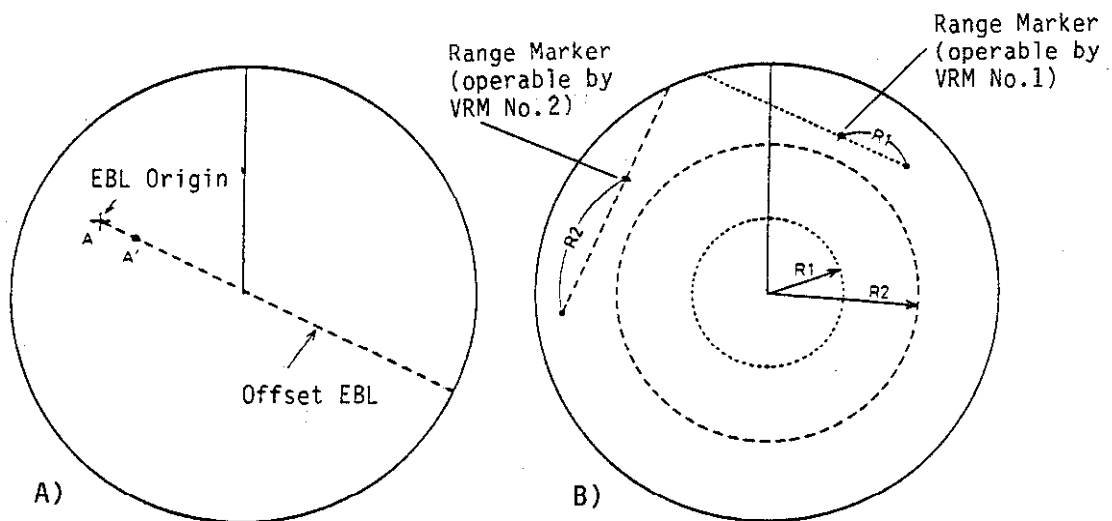


Fig. 12 Using the Offset EBL

5. To measure the range and bearing between two other targets activate the other EBL and VRM.
6. To return an EBL to the screen center press the [OFFSET/RESET] touchpad again.

#### Floating EBL (for N-type version)

1. Press the OFFSET/RESET key. The EBL origin is offset to the "+" cursor position. In this condition the EBL origin can be maneuvered by the joystick (or trackball) together with the "+" cursor.
2. To operate "+" cursor only, detach it from the EBL origin by pressing the [OFFSET/RESET] key: (EBL origin remains fixed.)
3. To return EBL origin to own ship position, press [OFFSET/RESET] key again.



## SETTING THE ALARM

An alarm may be set to sound should targets (ships, landmasses, etc.) above a certain signal level enter into a preset guard zone. The size of the guard zone may be set between 0 and maximum range for distance and between 0 and 360° in bearing.

This alarm is very effective as an anti-collision aid when using an autopilot or navigating in narrow channels. However, it does not relieve the operator of the responsibility to watch out for possible collision situations. It should never be used as a primary means to detect possible collision situations.

### Operating Procedure (for regular-type version)

1. Press the [SET/RESET] touchpad to enter the guard zone setting mode.
2. Press the [VRM ON] touchpad to display VRM No.1. Rotate the VRM rotary knob control to set the outer margin of the guard zone. Press [VRM ON] again and adjust the VRM rotary knob for setting with VRM No.2 the inner margin of the alarm.
3. Press the [EBL ON] touchpad to display EBL No.1. Rotate the EBL rotary knob control to set one of the sector margins. The guard sector is toward the right side of this EBL when viewed from the center. Press the [EBL ON] touchpad again and adjust the EBL rotary knob to set the other sector margin. The guard sector is toward the left of this margin when viewed from the center.
4. Press the [SET/RESET] touchpad. The annunciator "GUARD" is display at upper side of the screen.

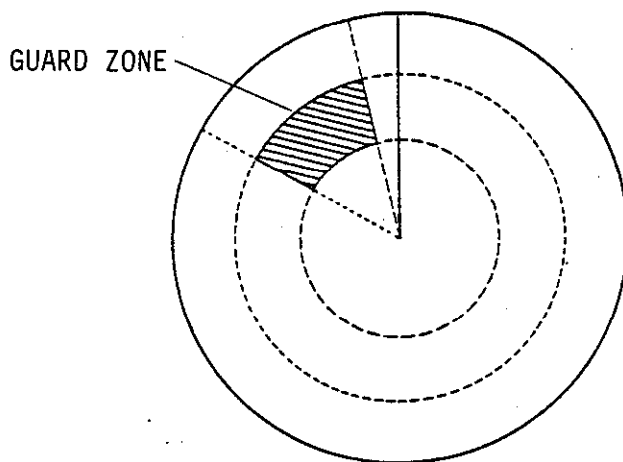


Fig. 13 Guard Zone

5. Should the alarm sound it can be stopped by pressing the [ACKN] touchpad. Press the touchpad once again to reactivate the alarm.
6. To change or erase the guard zone, keep the [SET/RESET] touchpad pressed for more than one second.

### Alarm Usage Caution

The alarm is given to the targets having a certain level of echo strength. This level does not always imply a landmass, reef, ships or other surface target but can mean returns from sea surface or precipitation. As the level is changeable with the environment, the operator is required to properly adjust the gain and anti-clutter controls. It should be noted that excessively high position of A/C controls can fail in alerting small targets.

### Operating Procedure (for N-type version)

1. Press the SET/RESET touchpad to enter the guard zone setting mode.
2. Press the VRM touchpad to display VRM; and then adjust the VRM control to set the outer margin of the guard zone. If you set the VRM reading to above 6 miles, the outer margin will be set to 6 miles ... maximum limit. If the VRM reading is set to less than 3.5 miles or VRM is not displayed (VRM off), the inner margin of the guard zone will be set to 3 miles ... minimum limit.
3. Press the EBL ON touchpad if the EBL is not displayed; and then adjust the EBL control to set the left margin of the guard zone. Press the EBL ON touchpad again to display the 2nd EBL which is indicated by long dash line. Adjust the EBL control to set the right margin of the guard zone. (EBL readout for the 2nd EBL is displayed below the 1st EBL readout.)  
Thereafter, each time the EBL ON touchpad is pressed, the valid EBL changes between 1st and 2nd EBL's.  
If the sector margin is not set (that is, no EBL displayed), the guard zone will be of circle (doughnut-shaped appearance).
4. Press the SET/RESET touchpad. The annunciator "GUARD" is displayed at upper side of the screen.
5. Should the alarm sound it can be stopped by pressing the ACKN touchpad. Press the touchpad again to reactivate the alarm.
6. To change or erase the guard zone, keep the SET/RESET touchpad pressed for more than 1 second.

## OFF-CENTERING THE PICTURE

On the Regular-type set, the sweep origin can be offset up to 50% of the selected range in any direction specified by the joystick (or trackball) cursor. On the N-type set, the sweep origin can be offset to the stern side by 50% of the selected range to provide an extended forward view, regardless of the cursor position.

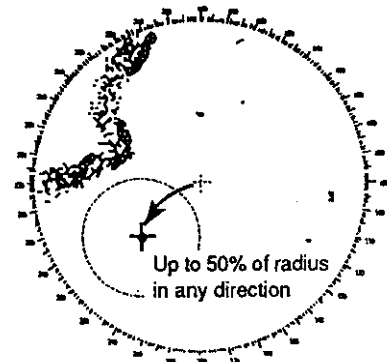
Off-centering is possible in relative motion head-up, north-up and course-up modes on the Regular-type, head-up mode only on the N-type.

Follow the steps shown to off-center the radar picture:

### Regular-type

1. Press the [JOYSTICK] touchpad to display the cursor on the screen if it is not already displayed. Place the cursor at a desired position by operating the joystick (or trackball).
2. Press the [SHIFT] touchpad.

The sweep origin will be offset to the cursor position if it is located within 50% of the range in use. If the cursor is located outside this area, the sweep origin will be moved to the limit of 50% of the radius, in the direction of the cursor.



Regular-type

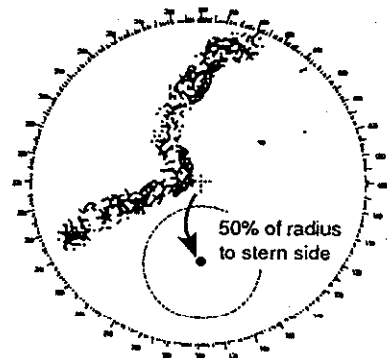
3. To cancel off-centering, press the [SHIFT] touchpad again.

### N-type

1. Make sure that the radar is set to the head-up mode.
2. Press the [SHIFT] touchpad.

The sweep origin will be offset by 50% of the range in use to the stern side, providing an extended forward view.

3. To cancel off-centering, press the [SHIFT] touchpad again.



N-type

## PLOTTING

The track of up to 10 operator-selected targets can be plotted manually, providing the operator with a history of target movement. Five plots/target are available on a first-in, first-out basis.

1. Display the cursor if it is not already displayed. Superimpose the cursor on the target desired by operating the joystick (or trackball).
2. Select a plotting symbol with the PLOT touchpads. The selected symbol is displayed in pink.
3. Press the [PLOT] touchpad, wait at least 30 seconds, place the cursor on the same target, select symbol and press the [PLOT] touchpad. If the touchpad is pressed within 3 seconds plotting is cancelled. For plotting other targets repeat the procedure.
4. CPA and TCPA will be indicated with a vector on the target.

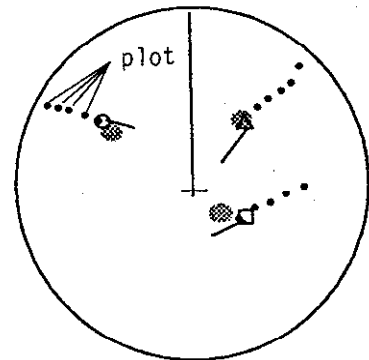


Fig. 15 Plot Display

### Target Vector

Trend of motion of each plotted target is shown by a vector. The vectors remain unchanged without being updated automatically; therefore, care should be taken to clear less important target vectors. Vector length, which is selectable by an internal DIP switch (see page AP1-1), is shown in the plot data table at the top of the screen.

## CANCELLING PLOTS

### Individual

Press [corresponding symbol] [CANCEL].

### All

Press [ALL] [CANCEL].

### Note

When the presentation mode is changed or when the [RESET] touchpad is pressed in the Course-up Mode, the past plots and vectors are all erased automatically.

## PLOT DATA TABLE

The plot data display table, an example of which is shown below, shows data about plotted targets and is located at the upper right side of the screen.

### Timer

The time shown is the time elapsed from the last plot entry.

### Range/Bearing to Plot Mark

Range and bearing to the last-entered plot mark are indicated. The bearing indication is relative to ship's head in the Head-up Mode, true (relative to North) in the North-up and Course-up Modes.

### Course/Speed of Plotted Target

Course and speed of last-plotted target are displayed. The displayed speed and course are always relative to own ship and suffixed with "R." Note that these indications are not updated during plot intervals.

### CPA, TCPA

Closest Point of Approach (CPA) and Time of Approach (TCPA) are displayed for the last-plotted target. Note that the CPA/TCPA indications are not updated during plot intervals.

### Vector

Vector length (time) is indicated.

TIME	10:00
RNG	11.3 NM
BRG	25.5° R
CSE	210.0° R
SPD	12.2 KT.R
CPA	0.3 NM
TCPA	17:08
VECTOR	6:00

Example of data for the target selected by the symbol  $\Delta$

Fig. 16 Plot Data Table

---

## ECHO AVERAGING

---

The [ECHO AVERAGE] touchpad is used to suppress sea clutter.

Echoes received from stable targets such as other ships (not moving at a fast relative speed to own ship) appear on the screen at almost the same position for every rotation of the sweep. On the other hand, unstable echoes such as sea clutter appear at random, sometimes making discrimination of target echoes difficult.

To distinguish target echoes from sea clutter, this radar uses the scan-to-scan correlation method. The scan-to-scan correlation method stores and averages successive picture frames. If the echo is stable it is presented in its actual strength level. And if it is unstable it is suppressed in brilliance, allowing you to discriminate targets from sea clutter.

To properly use the echo averaging facility, it is recommended to first suppress sea clutter with the A/C SEA control. Then, press the [ECHO AVG] touchpad. There are two levels of correlation, corresponding to the number of picture frames to be correlated, and the level in use is shown at the top of the screen. Each time the touchpad is depressed the level of suppression changes in the following sequence. Note that Level 3 does not provide correlation but picks up the peak level among several strobes in a frame. This level is useful for tracking a target echo masked by short-range sea clutter.

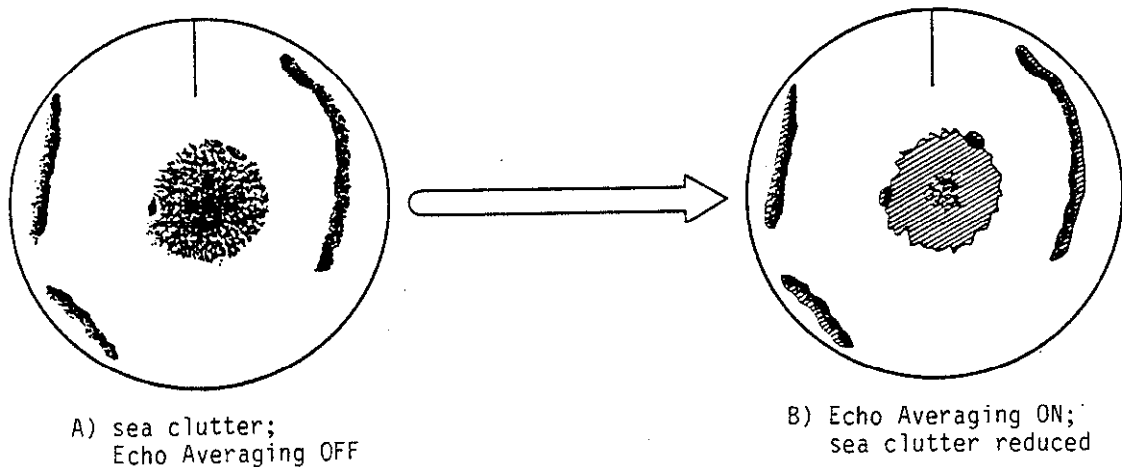
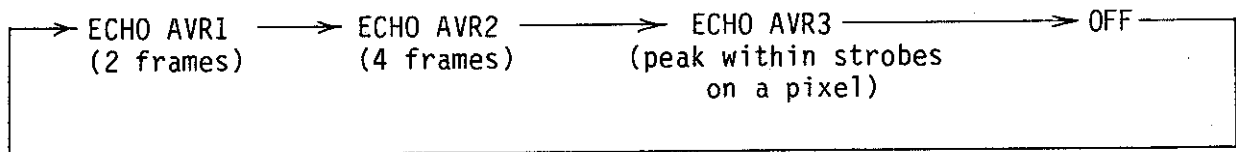


Fig. 17 Echo Averaging

### Echo Average Usage Cautions

Echo average should not be used under the following conditions.

- speed difference between own ship and other ships is large
- in Head-up Mode (level 3 may be used in the Head-up Mode)
- own ship is being subjected to heavy pitching and rolling

## ECHO STRETCH

On long ranges the echoes of targets are displayed only as small pips, making them difficult to see. To enhance target video on these ranges, press the [ECHO STRETCH] touchpad. The annunciator ECHO STR appears at the top of the screen.

The echo stretch function is effective when the pulselength is 0.3us or longer, i.e., on the 3nm and longer ranges when the FUNCTION Switch is set at SHORT pulse, the 0.75 nm and longer ranges at LONG pulse. Should you press the touchpad on a range where the echo stretch is ineffective, the annunciator ECHO STR appears in inversed video at the top of the screen.

### Caution

The echo stretch function magnifies not only small target pips but also returns from sea surface and rain and radar interference. For this reason, make sure these types of interference are sufficiently suppressed before activating this function.

## SUB PANEL

The sub panel located at the front of the display unit contains various switches and controls (see the Fig. below) not normally used in everyday operations. Access to these controls may be made by pulling the knob on the sub panel window.

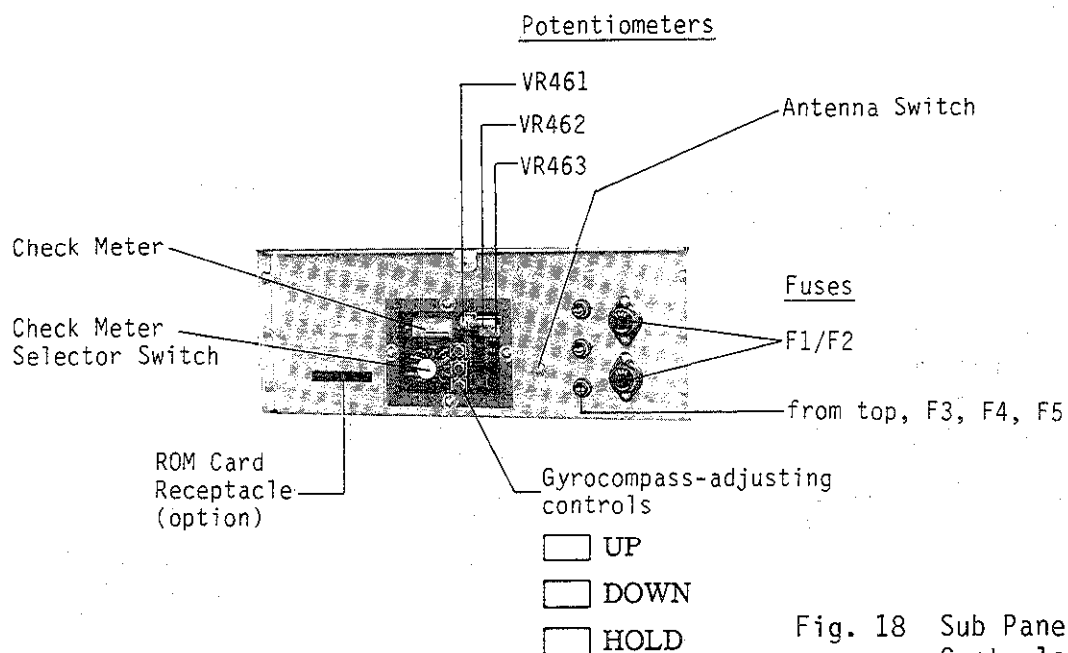


Fig. 18 Sub Panel Controls

## ANTENNA SWITCH

This switch turns the scanner on and off. (It is normally set to ON.)

## ROM CARD RECEPTACLE

The ROM card for use with the optional Video Plotter (RP-2) may be placed here.

## FUSES

Fuses are provided to protect components from overcurrent.

F1, F2 ..... Power line;  $\phi$ 10x38, 10A (AC), 30A (DC)  
F3 ..... TX-HV line;  $\phi$ 6x30, 0.5A  
F4 ..... Antenna motor;  $\phi$ 6x30, 5A  
F5 ..... Performance Monitor;  $\phi$ 6x30, 0.5A

## GYROCOMPASS-ADJUSTING CONTROLS

North-up and Course-up presentation modes require the compass signal in step-by-step or synchronous form. This adjustment is required when the radar is not synchronized with the gyrocompass. When the external A-D Converter AD-10S is used, the adjustment is made on its front panel.

1. Press the HOLD switch to disconnect the computing circuit from the gyrocompass.
2. Press the UP or DOWN switch until the compass reading is duplicated at the top of the bearing scale on the screen.
3. Press the HOLD switch again to engage the radar circuit with the gyrocompass (HOLD lamp will go off). If the gyro reading on the screen deviates from the compass reading, adjust it with the UP or DOWN switch.

## CHECK METER

Magnetron current, MIC detecting current, and output voltage of power supplies can be checked with the check meter.

Position of Selector Switch	Normal Reading on Check Meter
MAG. C (magnetron current)	4-8.5 †
TUN (tuning status)	5-10 †
DI. M (MIC detecting current)	6-8
-12V (output voltage)	5-9
+12V "	5-9
+5V "	5-9

† 48-mile range, transmitting; all others, 0.25-mile range, stand-by



## PRESET POTENTIOMETERS

Preset potentiometers are provided for coarse tuning (VR461), tuning A/C SEA (VR462), and eliminating main bang (VR463). Note that VR464 is not used.

### Coarse Tuning VR461

Whenever the magnetron and/or MIC is replaced, adjustment of this potentiometer is required. Proper tuning should be obtained with the TUNE control set at its mid-travel position.

1. Set the TUNE control to the mid position and then transmit the radar on the 48-mile range.
2. Turn VR461 fully clockwise, slowly return it counterclockwise, releasing hold when the longest tuning bar is displayed.

### A/C SEA VR462

If the A/C SEA control is not providing sufficient sea return suppression, adjust this control to increase its range.

1. Transmit the radar on the 12-mile range. Set up the following controls.  
A/C SEA: fully clockwise, A/C RAIN: fully counterclockwise, IR: OFF,  
A/C AUTO: OFF
2. Adjust the GAIN so that a slight amount of noise is displayed on the screen.
3. Adjust VR462 so that sea clutter is suppressed effectively (maximum range: 8 miles approximately).

### MBS (Main Bang Suppression) VR463

When the main bang appears on the display it can be eliminated by adjusting this potentiometer.

1. Set the range to 48 nm and after waiting 10 minutes, adjust the GAIN control so that a slight amount of noise is displayed on the screen.
2. Set the range to 0.25 nm and adjust the A/C SEA control to suppress sea clutter.
3. Rotate VR463, stopping when the main bang disappears.

## PERFORMANCE MONITOR

When the optional performance monitor is installed, turning the FUNCTION switch to PERF M will automatically set the radar to the 24-mile range scale with the long pulse and several arcs will be displayed to the stern side, opposite to the heading marker (when the monitor is installed behind the radar antenna).

If the radar transmitter and receiver are in good working order (original state when monitor was tuned), the innermost arc should appear at a range of 12nm with a total of 4 arcs. The range of the innermost arc reduces 3nm per every 3db deterioration in the transmitted power.

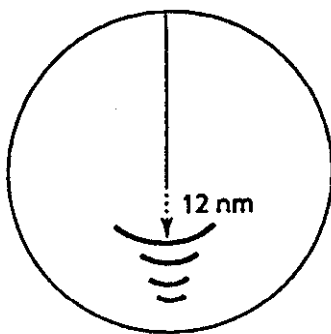
The receiver sensitivity can be evaluated by counting the number of arcs (see both the table below and Fig. 19 on the next page).

### Monitoring the transmitter

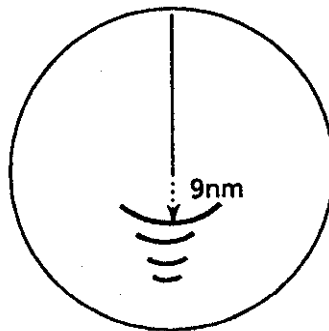
Range to innermost arc	Transmitter loss
12 nm	0 dB
9 nm	3 dB
6 nm	6 dB
3 nm or less or none	10 dB or more

### Monitoring the receiver

Number of arcs	Receiver loss
4	0 dB
3	3 dB
2	6 dB
1	9 dB or more
nil	12 dB or more

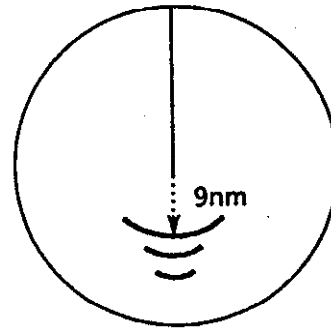


TRANSMITTER: NORMAL  
RECEIVER: NORMAL



TRANSMITTER: 3 dB loss  
(Transmitter system has lost half the initial power. Suspect the magnetron and feeder system.)

RECEIVER: NORMAL



TRANSMITTER: 3 dB loss  
(Transmitter system has lost half the initial power. Suspect the magnetron and feeder system.)

RECEIVER: 3 dB loss  
(Receiver system has lost half the normal sensitivity. Suspect receiver front end, water ingress to the feeder system, etc.)

Fig. 19 Performance Monitor Display

### Note

When the DIP Switch S3 #4 on the A-D CONV Board is not set up for performance monitor usage, the FUNCTION switch will not automatically set the range to 24nm. In this case, manually set the range to 24 nm.

FIGURE 20 LOCATION AND FUNCTION OF OPERATING CONTROLS

**POWER**

**BRILLIANCE**

**MODE**

**EBL**

**POWER switch**  
This switch turns the power on and off.

**HM touchpad**  
This touchpad controls the brilliance of the heading marker.

**PLOT SYMBOL touchpad**  
The brilliance of plot marks and vectors is controlled by this touchpad.

**DATA touchpad**  
The brilliance of alphanumeric data may be adjusted with this touchpad.

**JOYSTICK touchpad**  
This touchpad controls the brilliance of the cursor.

**RING touchpad**  
Pressing this touchpad adjusts the brilliance of the range rings.

**MARK touchpad**  
The brilliance of the VRMs, EBLs, Guard Zone and North Mark is controllable with this touchpad.

**PANEL DIM touchpad**  
Press this touchpad to adjust the brilliance of the touchpad panel.

**SELECT touchpad**  
Presentation mode, Head-up, Head-up/CG, Course-up, North-up, is selectable with this touchpad.

**RESET touchpad**  
Press this touchpad, in the Course-up Mode, to return the heading marker to 0 degree.

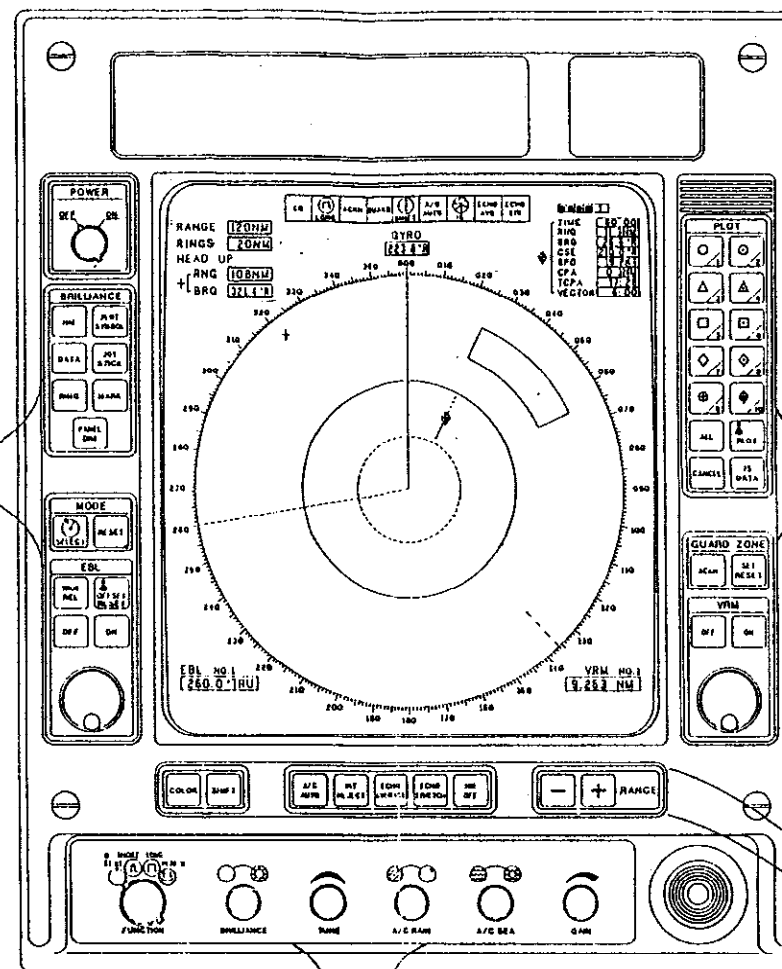
**TRUE REL touchpad**  
Pressing this touchpad alternates between true and relative bearing readout.

**OFFSET RESET touchpad**  
This touchpad offsets and resets the origin of an EBL.

**OFF touchpad**  
This touchpad may be pressed to erase an EBL.

**ON touchpad**  
This touchpad may be pressed to display an EBL.

**ROTARY knob control**  
This control maneuvers the EBLs.



**FUNCTION switch**  
This switch is used to set the radar in ST-BY, select pulse length and enable checking by the performance monitor.

**BRILLIANCE control**  
This control adjusts the brilliance of the CRT.

**TUNE control**  
This control tunes the receiver; adjust it to display the longest tuning bar.

**A/C RAIN control**  
Rain/snow returns may be suppressed with this control.

**A/C SEA control**  
Sea surface returns may be suppressed with this control.

**GAIN control**  
This control adjusts receiver sensitivity.

**JOYSTICK (or TRACKBALL)**  
This control maneuvers the cross-hair cursor.

**PLOT touchpads**  
When these touchpads are pressed in the plot mode, the corresponding symbol is displayed on the screen.

**ALL touchpad**  
This touchpad is used to erase the plot.

**PLOT touchpad**  
This touchpad, when pressed, activates the Plot Mode.

**CANCEL touchpad**  
This touchpad may be pressed to cancel plotting of individual targets or in combination with the ALL touchpad, all targets.

**JS DATA touchpad**  
This touchpad, if pressed when the cursor is displayed, turns on and off the joystick data table at the upper left-hand side of the screen.

**ACKN touchpad**  
This touchpad may be pressed to temporarily deactivate/reactivate the guard zone.

**SET RESET touchpad**  
Press this touchpad to enable setting and resetting of the guard zone.

**OFF touchpad**  
This touchpad may be used to erase a VRM.

**ON touchpad**  
Press this touchpad to display a VRM.

**ROTARY knob control**  
Rotate this control to maneuver the VRMs.

**COLOR touchpad**  
Display color scheme may be selected with this touchpad.

**SHIFT touchpad**  
Pressing this key offsets the sweep origin within 50% of the range of the use.

**A/C AUTO touchpad**  
Automatic suppression of returns from sea surface and/or rain clutter can be done with this touchpad.

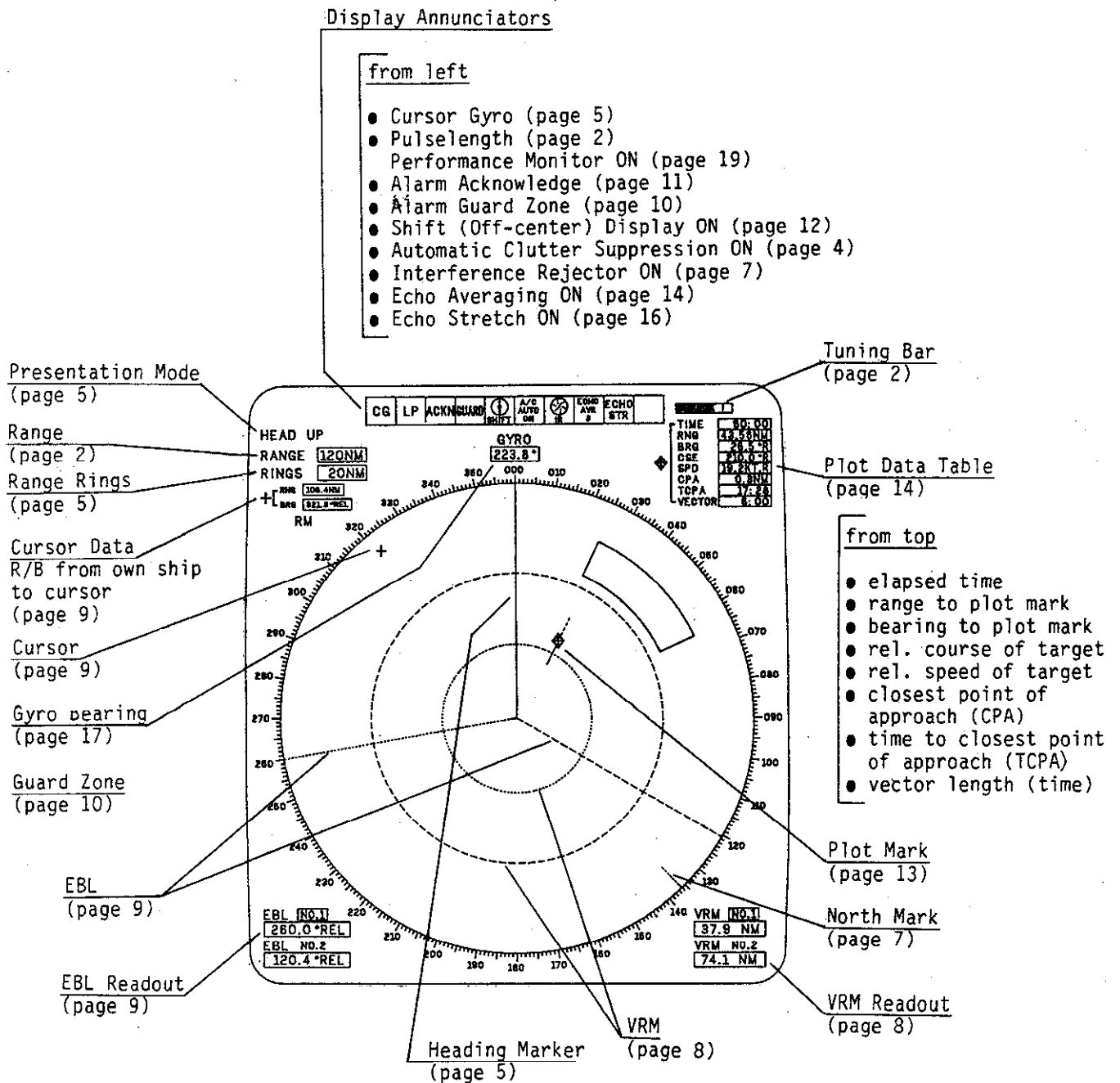
**INT REJECT touchpad**  
This touchpad enables/disables the interference rejecting circuit.

**ECHO AVERAGE touchpad**  
Sea surface returns can be suppressed in three levels by this touchpad.

**ECHO STRETCH touchpad**  
Press this touchpad on long ranges to enhance target detection ability.

**HM OFF touchpad**  
Press and hold this touchpad to erase the heading marker and north marker. Release hold to redisplay them.

**RANGE SELECTION touchpads**  
These two touchpads select a range.



NOTE: EBL No.2 and VRM No.2 are not provided for N-type version.

FIGURE 21 LOCATION OF MARKERS, LEGENDS & ANNUNCIATORS

## APPLICATION

In this section, minimum and maximum ranges, radar resolution, range measurement, false echoes and radar plotting are discussed.

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### MINIMUM AND MAXIMUM RANGES

---

#### MINIMUM RANGE

When the radar is used as a collision avoidance aid, the minimum detection range is of urgent concern. It is very dangerous for a target to disappear when it approaches the ship. The minimum range is primarily determined by the height of the antenna (vertical beam width of antenna) above the waterline.

#### MAXIMUM RANGE

The maximum detecting range of the radar,  $R_{max}$ , varies considerably depending upon several factors such as the height of the antenna above the waterline, the height of the target above the sea, the size, shape and material of the target, and the atmospheric conditions.

Under normal atmospheric conditions, the maximum range is equal to the radar horizon or a little shorter. The radar horizon is longer than the optical one by about 6% because of the diffraction property of the radar signal. The  $R_{max}$  is given in the following equation.

$$R_{max} = 2.2 \times (\sqrt{h_1} + \sqrt{h_2})$$

where  $R_{max}$ : radar horizon (nm)  
     $h_1$  : antenna height (m)  
     $h_2$  : target height (m)

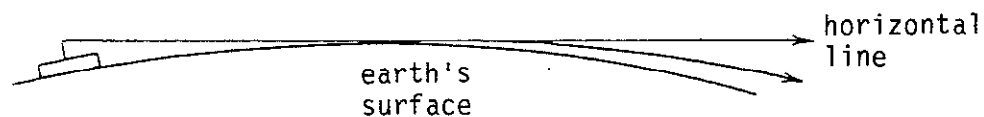


Fig. 22 Radar Horizon

For example, if the height of the antenna above the waterline is 9 meters and the height of the target is 16 meters, the maximum radar range is;

$$R_{max} = 2.2 \times (\sqrt{9} + \sqrt{16}) = 2.2 \times (3 + 4) = 15.4 \text{ nm}$$

---

## RADAR RESOLUTION

---

### BEARING RESOLUTION

Bearing resolution is the ability to display as separate pips the echoes received from two targets which are at the same range and close together. It is proportional to the antenna length and reciprocally proportional to the wavelength. The length of the antenna radiator should be chosen for a bearing resolution better than  $2.5^\circ$  (IMO Resolution). This condition is normally satisfied with a radiator larger than 1.2 m (4 ft).

### RANGE RESOLUTION

Range resolution is the ability to display as separate pips the echoes received from two targets which are on the same bearing and close to each other. This is determined by pulselength only. The usual discrimination range is 22.8 m (25 yd) on a 0.08 microsecond pulse.

---

## BEARING ACCURACY

---

One of the most important features of the radar is how accurately the bearing of the target can be measured. The accuracy of bearing measurement basically depends on the narrowness of the radar beam. However, the bearing is usually taken relative to the ship's heading, and thus, proper adjustment of the heading marker at installation is an important factor in ensuring bearing accuracy. To minimize error when measuring the bearing of a target, put the target echo at the extreme position on the screen by selecting a suitable range.

---

## RANGE MEASUREMENT

---

Measurement of the range to a target is also a very important function of the radar. Generally, there are two means of measuring range: the fixed range rings and the variable range marker (VRM). The fixed range rings appear on the screen with a predetermined interval and provide a rough estimate of the range to a target. The variable range marker's diameter is increased or decreased so that the marker touches the inner edge of the target, allowing the operator to obtain more accurate range measurements.

## FALSE ECHOES

Occasionally echo signals appear on the screen at positions where there is no target or disappear even if there are targets. They are, however, recognized if you understand the reason why they are displayed. Typical false echoes are shown below.

### MULTIPLE ECHOES

Multiple echoes occur when a short range, strong echo is received from a ship, bridge, or breakwater. A second, a third or more echoes may be observed on the display at double, triple or other multiples of the actual range of the target as shown in Fig. 23. Multiple reflection echoes can be reduced and often removed by decreasing the gain or properly adjusting the A/C SEA control.

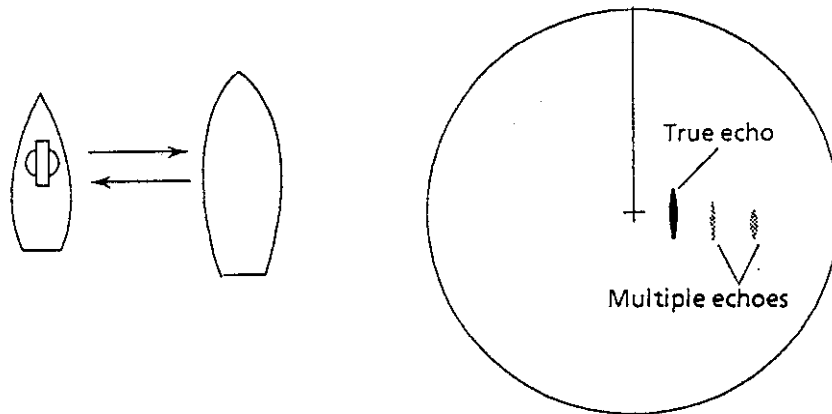


Fig. 23 Multiple Echoes

### BLIND AND SHADOW SECTORS

Funnels, stacks, masts, or derricks in the path of antenna may reduce the intensity of the radar beam. If the angle subtended at the scanner is more than a few degrees, a blind sector may be produced. Within the blind sector small targets at close and long ranges may not be detected. See Fig. 24.

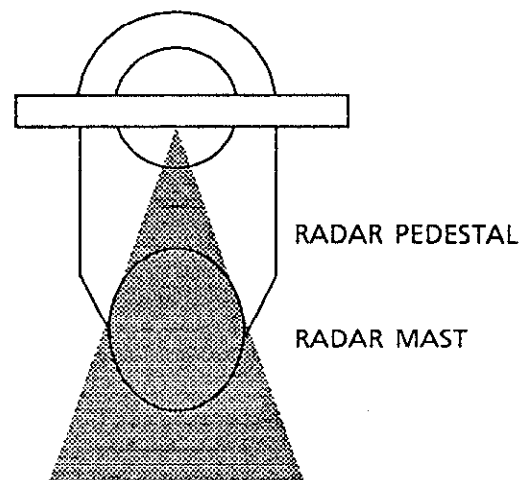


Fig. 24 Blind and Shadow Sectors



## SIDELOBE ECHOES

Every time the radar pulse is transmitted, some radiation escapes on each side of the beam--called "sidelobes." If a target exists where it can be detected by the side lobes as well as the main lobe, the side echoes may be represented on both sides of the true echo at the same range, as shown in Fig. 25. Side lobes show usually only on short ranges and from strong targets. They can be reduced through careful reduction of the gain or proper adjustment of the A/C SEA control.

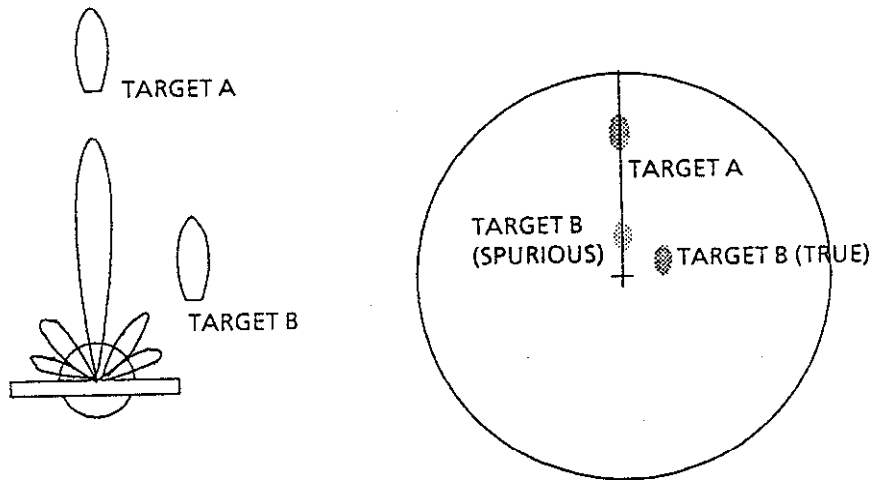


Fig. 25 Sidelobe Echoes

## VIRTUAL IMAGE

A relatively large target close to your ship may be represented at two positions on the screen. One of them is the true echo directly reflected by the target and the other is a false echo which is caused by the mirror effect of a large object on or close to your ship as shown in Fig. 26. If your ship comes close to a large metallic bridge, for example, such a false echo may temporarily be seen on the screen.

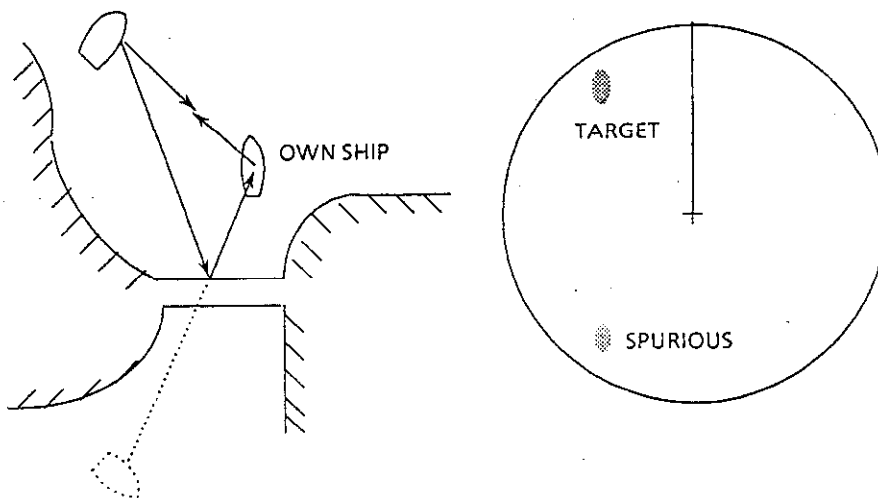


Fig. 26 Virtual Image

## POSITION FIXING WITH RADAR

### RADAR RANGE

The simultaneous measurement of the ranges to two or more fixed objects is normally the most accurate method of obtaining a fix with radar alone. Preferably at least three ranges should be used. However the use of more than three range arcs may introduce excessive error because of the time lag between measurements, i.e., you will be moving as you take successive measurements.

When obtaining a fix, it is best to measure the most rapidly changing range last because of a smaller time lag in the radar plot from the ship's actual position. For greater accuracy, the objects selected should provide arcs with angles of cut as close to  $90^\circ$  as possible. Small, isolated, radar-conspicuous fixed objects whose associated range arcs intersect at angles approaching  $90^\circ$  provide the most reliable and accurate position fixes. Objects at longer ranges are less accurate for position fixing because they may be below the radar horizon and because the width of the radar beam increases with range.

To fix your position, first measure the range to two or more prominent navigational marks which you can identify on the chart. Next, with a compass sweep out the ranges from the charted positions. The point of intersection of the arcs is your estimated position.

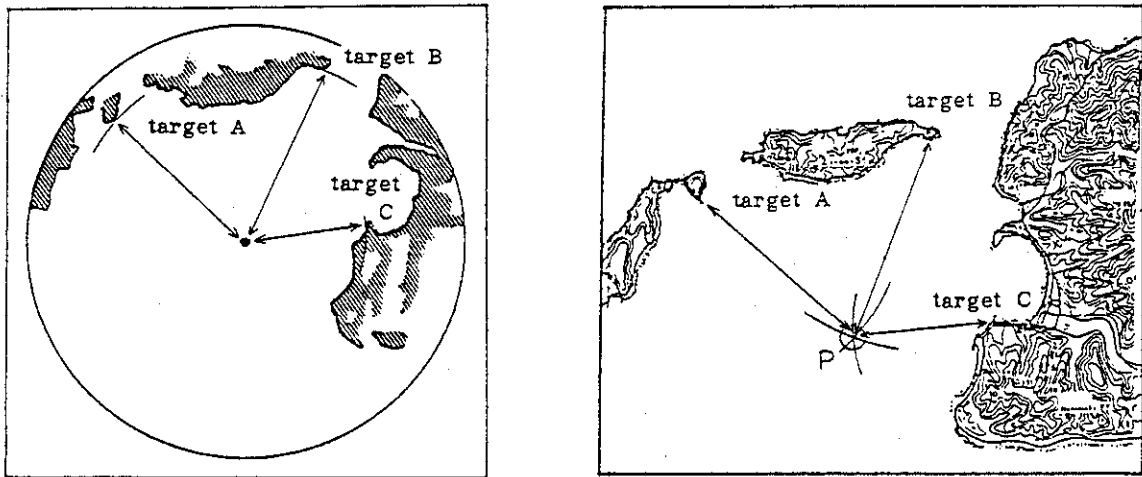


Fig. 27 Position Fixing Using Range

### RANGE AND BEARING

The advantage of position fixing by range and bearing is the speed with which a fix can be obtained. A distinct disadvantage however is that this method is based upon only two intersecting position lines, a bearing line and range, obtained from two points of land. If possible, the object used should be small, isolated and identified with reasonable certainty.

To fix your position using range and radar bearing, measure the relative bearing of the target with the EBL, noting the exact direction of the ship's heading when doing so. Next, make allowance for compass deviation (true or magnetic) and find the true bearing of the target. Sweep out the range to the target with a compass on the chart and plot the true bearing of the target. The point of intersection is your approximate position.

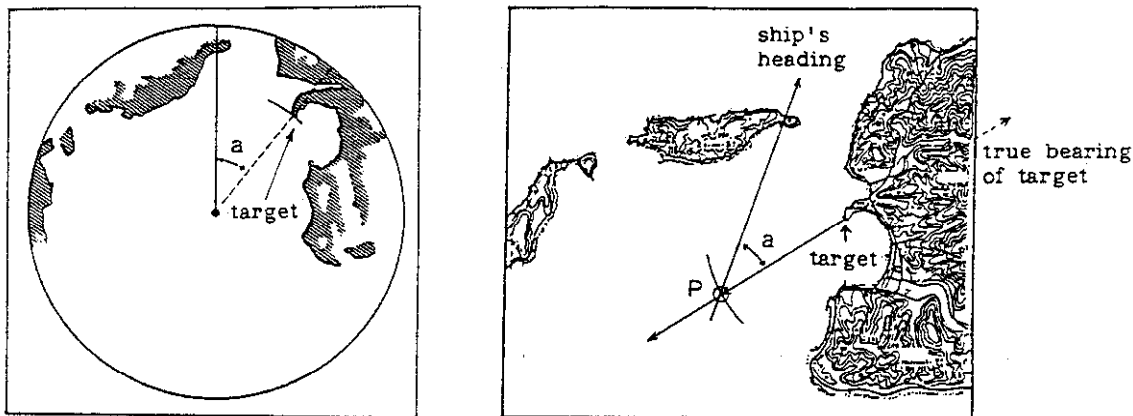


Fig. 28 Position Fixing Using Range and Bearing

**TWO BEARINGS**

Generally, fixes obtained from radar bearing are less accurate than those obtained from intersecting range arcs. The accuracy of fixing by this method is greater when the center bearings of small, isolated radar-conspicuous objects can be observed. Similar to position fixing using range and bearing, this method affords a quick means for initially determining approximate position. The position should then be checked against other means to confirm reliability.

Position fixing using two bearings is determined by measuring the relative bearings for the two targets and then determining their true bearings. Plot the two bearings on the chart; the point of intersection of the two bearings is your approximate position.

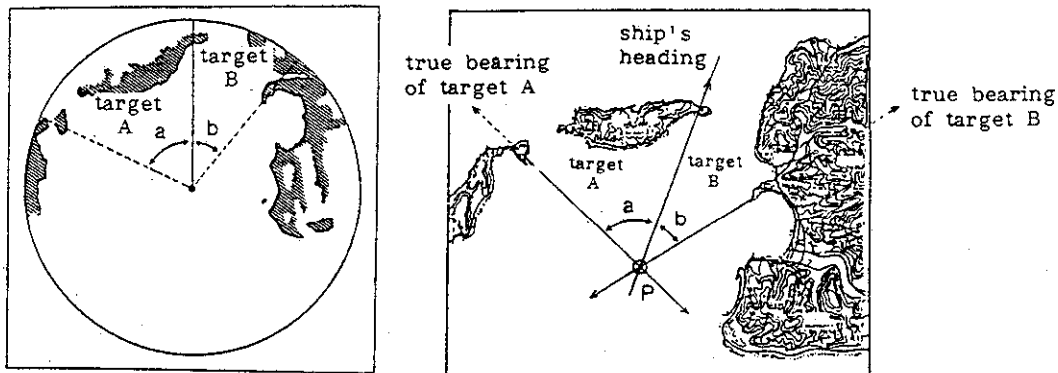


Fig. 29 Position Fixing Using Two Bearings

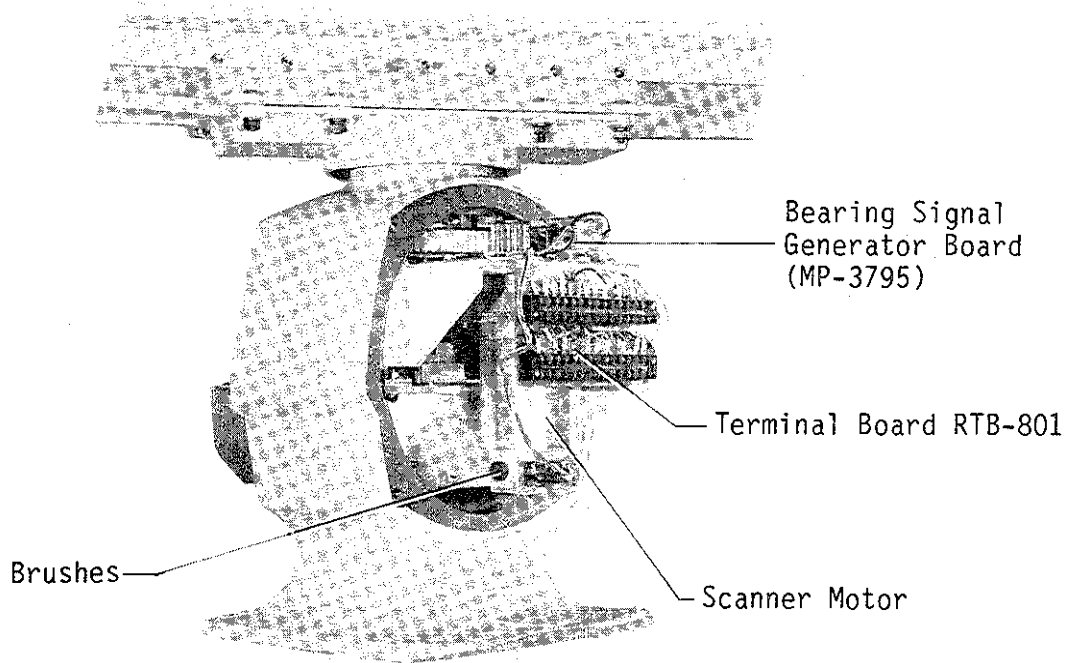
## MAINTENANCE

Good performance depends on regular maintenance. Following the recommended maintenance checks prescribed in this section will not only prevent unexpected malfunctions but will also lengthen equipment life.

Before beginning maintenance work, be sure to switch off the radar at the main switchboard. When checking inside the units, wait for a few minutes until the high voltage components (CRT or HV capacitors) can discharge the residual charge.

Interval	Check Point	Check/Measures	Remarks
3 to 6 months	Exposed nuts and bolts on scanner unit	Check for corroded or loosened nuts/bolts. If necessary, clean them and repaint thickly. Replace them if heavily corroded.	*Sealing compound may be used instead of paint. *Put slight amount of grease if nuts and bolts are replaced.
	Scanner radiator	Check for dirt or cracks on the radiator surface. Thick dirt should be wiped off by using a soft cloth immersed in fresh water. If a crack is found, apply a slight amount of sealing compound or adhesive as first-aid treatment, then call for repair.	*Do NOT use plastic solvent (acetone) for cleaning. *If removing ice on the scanner unit, use a wooden hammer or plastic-head hammer. Crack on the unit may cause water ingress, causing permanent damage to the circuits inside.
	Terminal boards and plugs in scanner unit	Open scanner cover to check terminal board/plug connections inside. Also check if the rubber packing of the scanner cover is in good order.	*When putting cover back in position, be careful not to catch flying wires between cover and unit.
	CRT screen	Dirt on CRT creates symptoms identical to poor sensitivity. Clean CRT surface carefully.	*Use a soft cloth with a slight amount of anti-static-charge spray. <u>NEVER USE PLASTIC SOLVENT.</u>

Interval	Check Item	Check/Measures	Remarks
6 months to 1 year	Scanner motor (See Fig. 30.)	Check and clean carbon brushes and commutator. If brushes have worn out or abnormal spark is seen replace them.	*Under normal use, the carbon brush will last approx. 2000 hours.
	Timing disc (See Fig. 31.)	Carbon given off from the drive motor may fall in slit of this disc, causing the sweep to jump erratically.	*Clean the disc with a brush.
once a year	CRT anode and approach	High tension on CRT attracts dust in environment, and moist dust will cause poor insulation. <u>ASK YOUR DEALER TO CLEAN ANY HIGH VOLTAGE PARTS.</u>	*If any crack is found on rubber cap or wire sheath, ask your dealer to replace damaged part.
	Terminal boards, sockets and plugs	Check for loose connections. Clean contacts or replace plug, if necessary.	



N Photo No. 639

Fig. 30

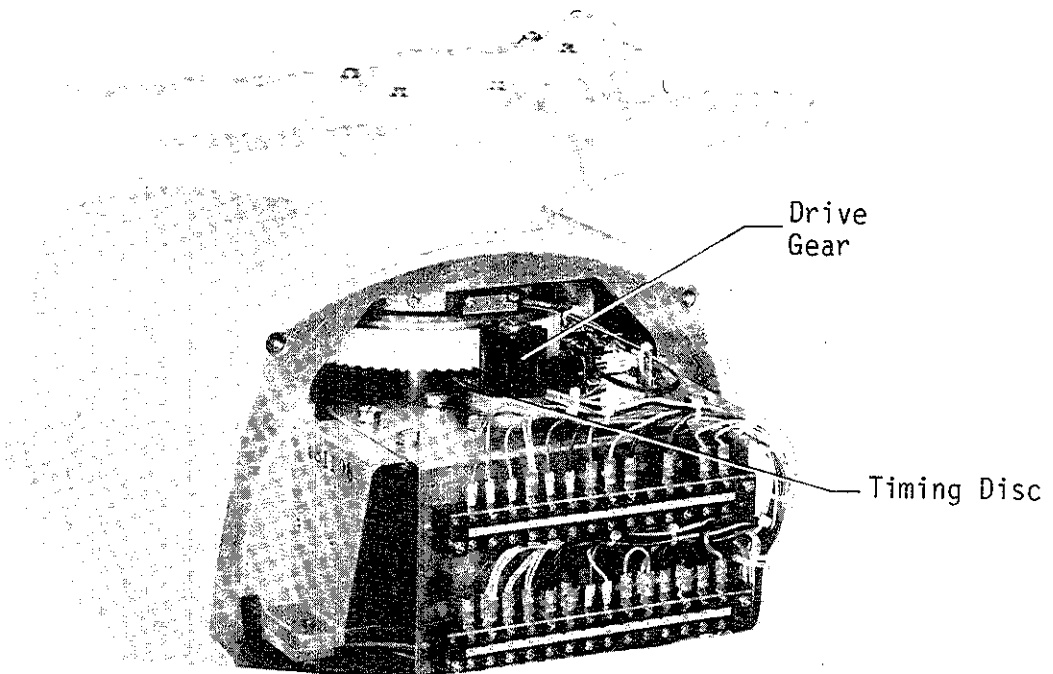


Fig. 31

## TROUBLESHOOTING

Whenever you suspect the radar is not functioning properly, turn it off and check plug connections on p.c. boards. If plug connections are secure, proceed to the Trouble Finding List beginning on the next page. If a board is found to be faulty, replace it or call for service. Do not attempt further component check on any p.c. board. Careless handling may permanently damage the board.

### "CAUTION"

There are many high tension points in the radar system. Take special care when approaching the following parts.

1. Power supply circuit (Display Unit)
2. CRT circuit (Display Unit)
3. Modulator circuit (Scanner Unit)
4. Magnetron (Scanner Unit)

Operation	Symptom	Check Point	Remarks
Turn Power on and adjust panel brightness with [PANEL DIM] touchpad.	Panel does not light up at any touchpad setting (other than OFF).	<ol style="list-style-type: none"> <li>1. Blown power fuse F1, F2</li> <li>2. Mains voltage/polarity</li> <li>3. Power Supply Board</li> <li>4. Illumination lamps</li> </ol>	<p>*Measure mains voltage at DTB3 #1(+) and #3(-).</p> <p>DC Spec: 20.4 to 40VDC AC Spec: 100/110/115 VAC (+ 10%)</p>
Adjust BRILLIANCE control.	Nothing appears on the display.	<ol style="list-style-type: none"> <li>1. CRT</li> <li>2. CRT Voltage</li> <li>3. Memory Board</li> </ol>	*If CRT heater is lit, CRT is normal.
	Scanner is not rotating. (The message "NO BP" is displayed when bearing pulse is not received during ST-BY.)	<ol style="list-style-type: none"> <li>1. Scanner Switch is OFF.</li> <li>2. Blown scanner fuse F4 (5A)</li> <li>3. Scanner Motor Brushes</li> <li>4. Scanner rotating mechanism jammed</li> <li>5. Power supply circuit for scanner motor</li> </ol>	
After ST-BY appears, begin transmitting.	Marks, etc. are not displayed.	<ol style="list-style-type: none"> <li>1. A/D Board</li> <li>2. Memory Board</li> </ol>	
	Picture synchronization is abnormal.	<ol style="list-style-type: none"> <li>1. CRT assembly (Deflection Board, etc.)</li> <li>2. Memory Board</li> </ol>	

Continued



Operation	Symptom	Check Point	Remarks
Adjust GAIN control with A/C SEA control set at minimum.	Marks and legends appear but no noise nor echo.	<ol style="list-style-type: none"> <li>1. IF amplifier</li> <li>2. Multicore cable between the scanner and display</li> <li>3. Video Amplifier Board</li> </ol>	*Check continuity and isolation of coaxial cable (Note: Disconnect the plug and lugs at both ends of coaxial cable before checking it by ohmmeter.)
	Marks, legends and noise appear but no echo. (No transmission leak appears.)	<ol style="list-style-type: none"> <li>1. TX fuse F3 (0.5A)</li> <li>2. Magnetron</li> <li>3. MODULATOR board</li> <li>4. MODULATOR TRIGGER board</li> <li>5. Modulator SCR</li> <li>6. A/D Board</li> <li>7. Memory Board</li> </ol>	<p>*If fuse is blown replace it. If it blows again, the magnetron or modulator circuit may be faulty.</p> <p>*Check magnetron current with the check meter in the sub panel.</p>
	Sweep rotation is not synchronized with antenna rotation.	<ol style="list-style-type: none"> <li>1. Bearing Signal Generator Board (Scanner unit)</li> <li>2. A/D Board</li> </ol>	
	Abnormal bearing of picture.	<ol style="list-style-type: none"> <li>1. A/D Board</li> <li>2. Memory Board</li> <li>3. Gyro Interface Board</li> </ol>	*The message "NO HD" appears on the screen when heading pulse is not received during ST-BY.

Continued

Operation	Symptom	Check Point	Remarks
Adjust TUNE control.	Poor sensitivity	<ol style="list-style-type: none"> <li>1. Deteriorated magnetron</li> <li>2. Detuned MIC</li> <li>3. Dirt on radiator face</li> </ol>	<p>*With the radar transmitting on the 48nm range, check magnetron current with the check meter. If the current is below the normal value, magnetron may be defective.</p> <p>*Check MIC detecting current with the check meter. If it is below the normal value, MIC may have become detuned.</p>
Change range.	Radar picture does not change.	<ol style="list-style-type: none"> <li>1. Defective RANGE touchpad</li> <li>2. A/D Board</li> <li>3. Memory Board</li> <li>4. Mother Board</li> </ol>	
Activate Int. Rej. circuit.	Int. Rej. not performed ("IR" not displayed).	<ol style="list-style-type: none"> <li>1. Bad contact of touchpad</li> <li>2. A/D Board</li> <li>3. Mother Board</li> </ol>	
Activate Echo Stretch.	Echo Stretch not performed ("ECHO STR" not displayed).	<ol style="list-style-type: none"> <li>1. Bad contact of touchpad</li> <li>2. A/D Board</li> <li>3. Mother Board</li> </ol>	
Operate [RING] touchpad.	Range rings are not displayed.	<ol style="list-style-type: none"> <li>1. Bad contact of touchpad</li> <li>2. Marker Board</li> </ol>	

Continued

## Defective Touchpads

If any touchpad is not operating properly, first suspect bad contact of the touchpad. If there is good contact, the Memory Board or Marker Board may be defective.

## APPENDIX 1 DIP SWITCHES

The specifications of this radar can be changed by DIP switches S3 and S2, located on the A/D Board and Marker Board, respectively. The settings of these DIP switches are displayed whenever the power is turned on. The specifications selectable by each DIP switch are given in the tables below.

Table AP-1 Specifications of DIP Switch S3 (A/D Board)

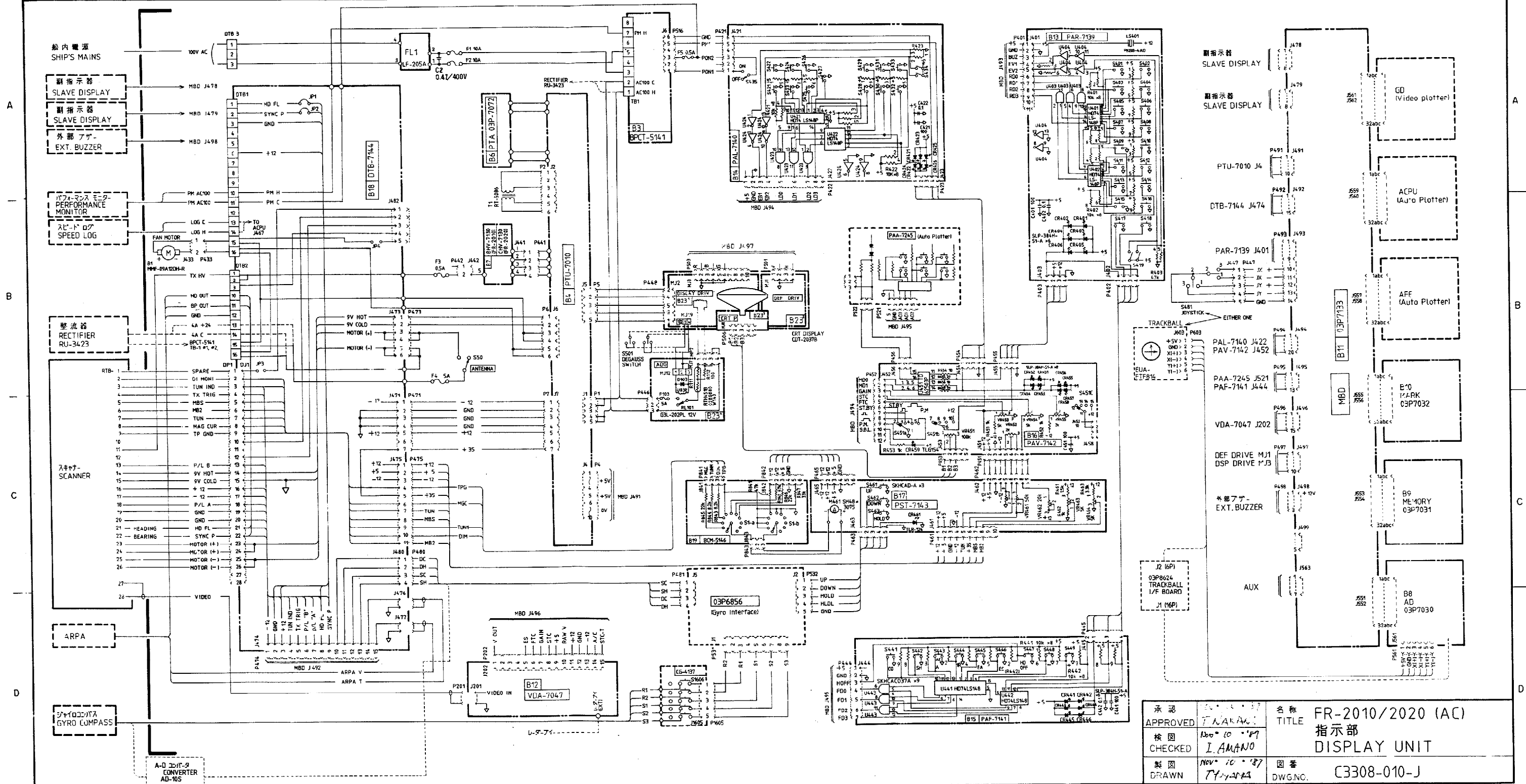
No.	Specification	OFF	ON
1	Alteration Prohibited		
2	Use of Echo Averaging Levels 1 & 2 in the Head-up Mode	NO†	YES
3	VRM Measuring Unit *	NM† KM	NM SM
4	Performance Monitor Connection	NO†	YES
5	Transmission when antenna rotation is suspended	ST-BY†	TX
6	Display ship's stern mark	NO†	YES
7	Radar type	REGULAR†	N
8	Radar selection	MASTERT	SLAVE

\*: VRM unit selection is not provided for N-type version.

Table AP-2 Specifications of DIP Switch S2 (Mark Board)

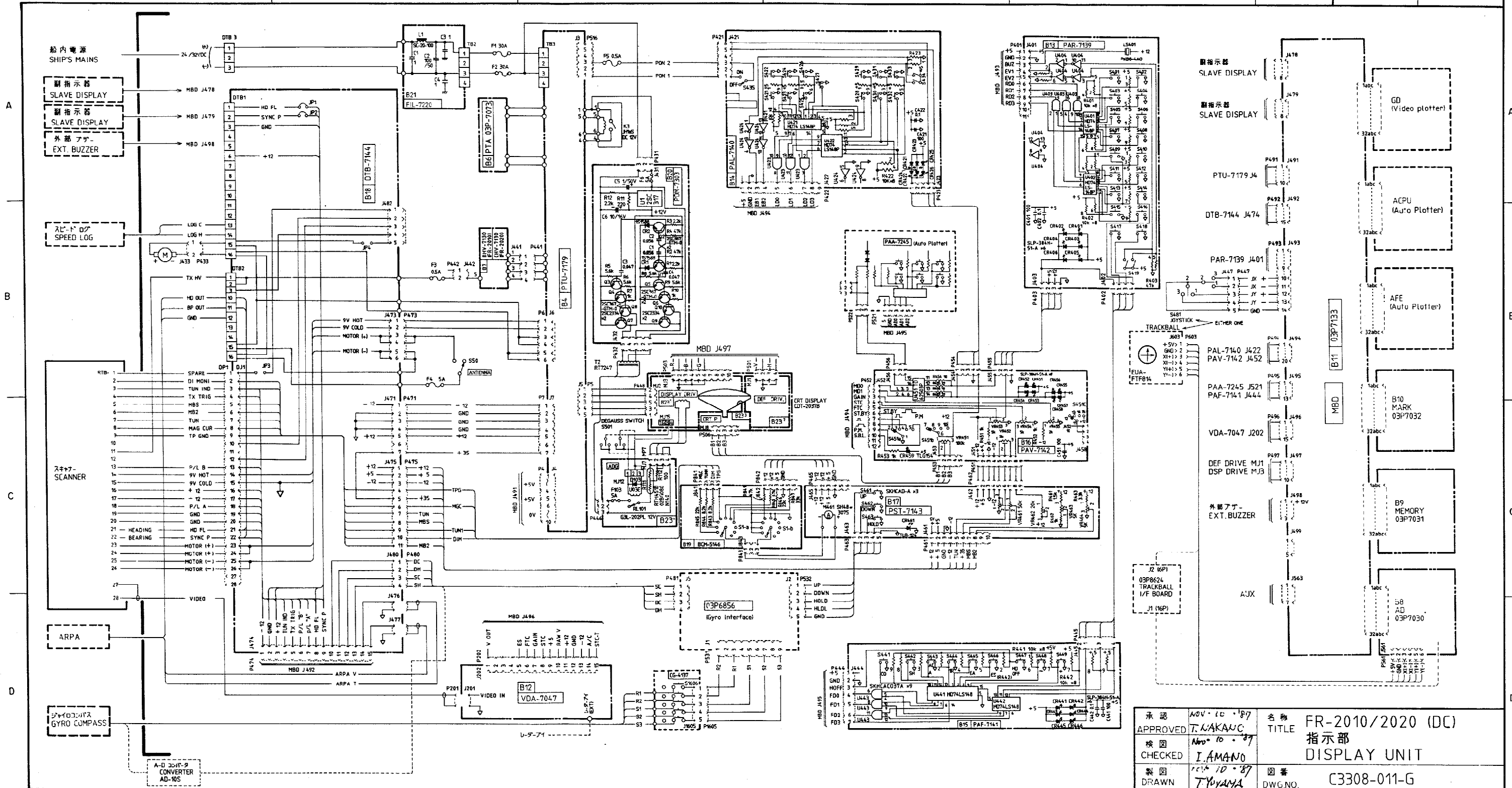
No.	Specification	OFF	ON		
7	Speed Vector Display	NO	YES†		
5	Vector Length				
6		30 sec.	1 min.	3 min.	6 min.
5		OFF	ON	OFF	ON†
6	OFF	OFF	ON	ON†	

† factory setting



承認 APPROVED	名 TAKAKAWA	名称 TITLE	FR-2010/2020 (AC) 指示部 DISPLAY UNIT
検 CHECKED	日 1987.10.10	製 I. AMANO	図番 DWG.NC. C3308-010-J
製 DRAWN	日 1987.10.10	製 TY. YAMADA	

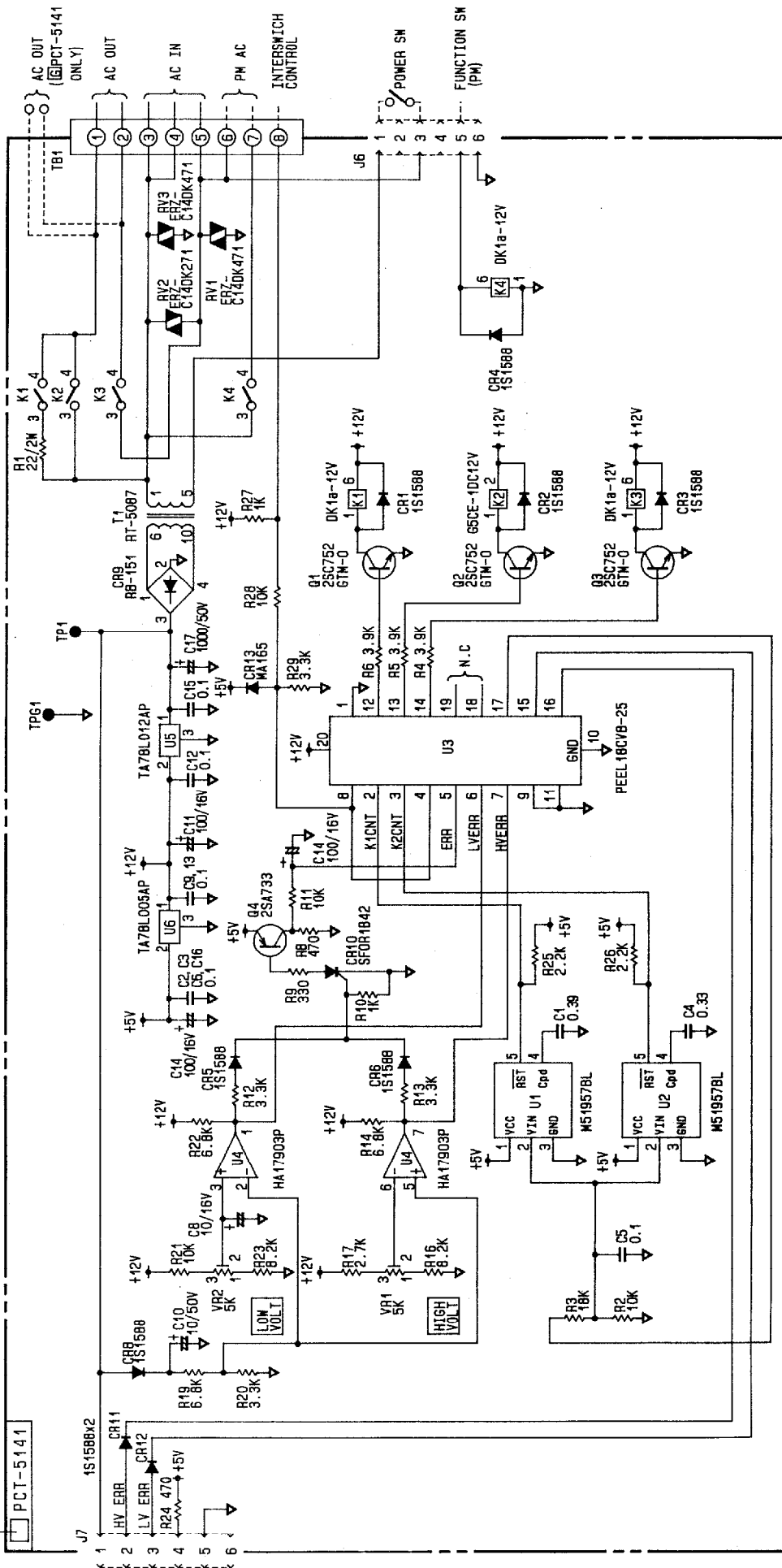
FURUNO ELECTRIC CO., LTD.



承認 APPROVED	NOV 10 '87 T. WAKAUG	名物 TITLE	FR-2010/2020 (DC) 指示部 DISPLAY UNIT
検図 CHECKED	Nov 10 '87 I. AMANO	図番 DWG. NO.	C3308-011-G
製図 DRAWN	10/10 '87 T. YUYAMA		

FURUNO ELECTRIC CO., LTD.

F: FR-2010/2020/2030S/2010T/2020T/2001/2011/2021  
 FR/FAR-2800 SERIES, FR-1400 SERIES, FCR-1400 MARK-3 SERIES  
 G: FR-2020X/2050X/2050T/2032S/2060S



NOTE: 特記なき抵抗の単位はΩ, 1/6W, コンデンサの単位はμF.  
 ALL RESISTANCE IN OHMS, 1/6W AND CAPACITANCE  
 IN MICROFARADS UNLESS NOTED OTHERWISE.

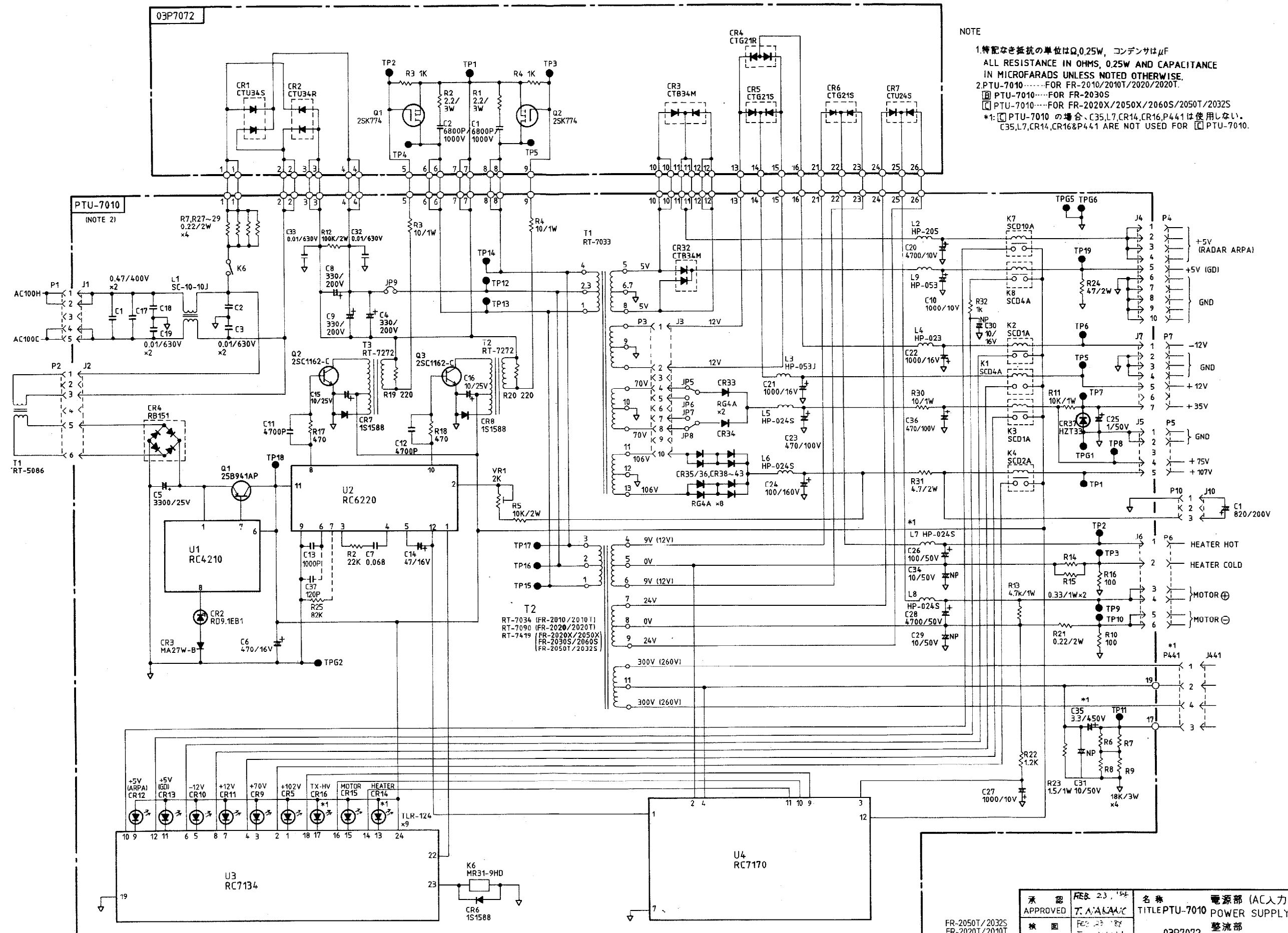
承認 APPROVED	JUN・22・'92 I. NAKANO	名称 TITLE	F / G PCT-5141 AC電源保護基板
検図 CHECKED	JUN・22・'92 N. SAITO	製図 DRAWN	AC POWER PROTECTION BOARD
製図 DRAWN	JUN・22・'92 I. AMANO	図番 DWG. NO.	C3263-028-S

**FURUNO ELECTRIC CO., LTD.**

03P7072

NOTE

1. 特記なき抵抗の単位はΩ, 0.25W, コンデンサはμF  
 ALL RESISTANCE IN OHMS, 0.25W AND CAPACITANCE  
 IN MICROFARADS UNLESS NOTED OTHERWISE.  
 2. PTU-7010 ----- FOR FR-2010/2010T/2020/2020T.  
 □ PTU-7010 ----- FOR FR-2030S  
 □ PTU-7010 ----- FOR FR-2020X/2050X/2060S/2050T/2032S  
 \*1: □ PTU-7010 の場合、C35, L7, CR14, CR16, P441 は使用しない。  
 C35, L7, CR14, CR16 & P441 ARE NOT USED FOR □ PTU-7010.



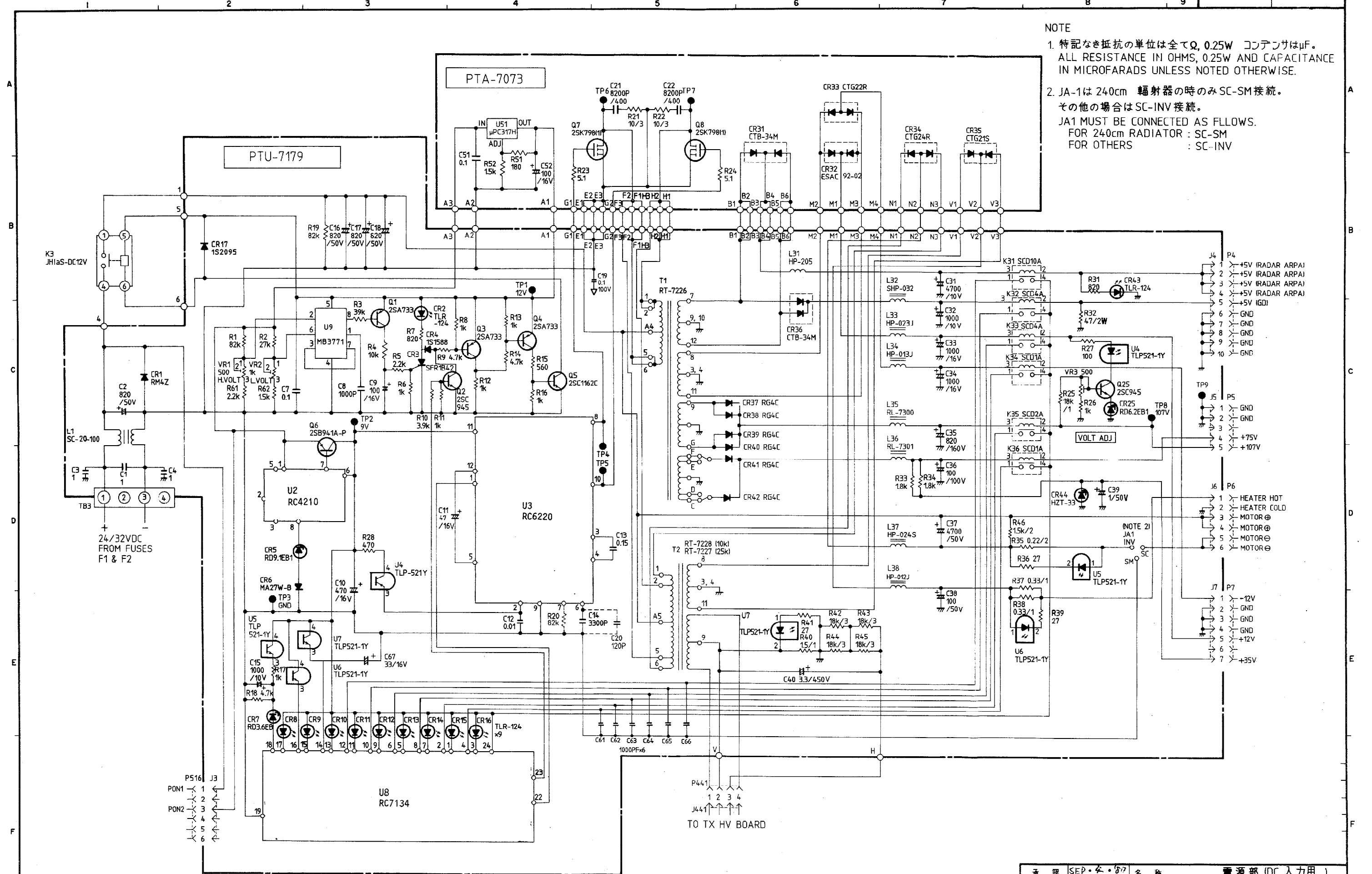
承認 APPROVED	REB 2.3.154 T. A. A. A. C.	名称 TITILEPTU-7010	電源部 (AC入力用) POWER SUPPLY CKT
検閲 CHECKED	Feb 23 1954 T. A. A. A. C.	03P7072	整流部 RECTIFIER CKT
製図 DRAWN	Feb 23 1954 I. A. M. A. C.	図番 DWG. NO.	C3308-014-L

FR-2050T/2032S  
 FR-2020T/2010T  
 FR-2030S/2060S  
 FR-2020X/2050X  
 FR-2010/2020



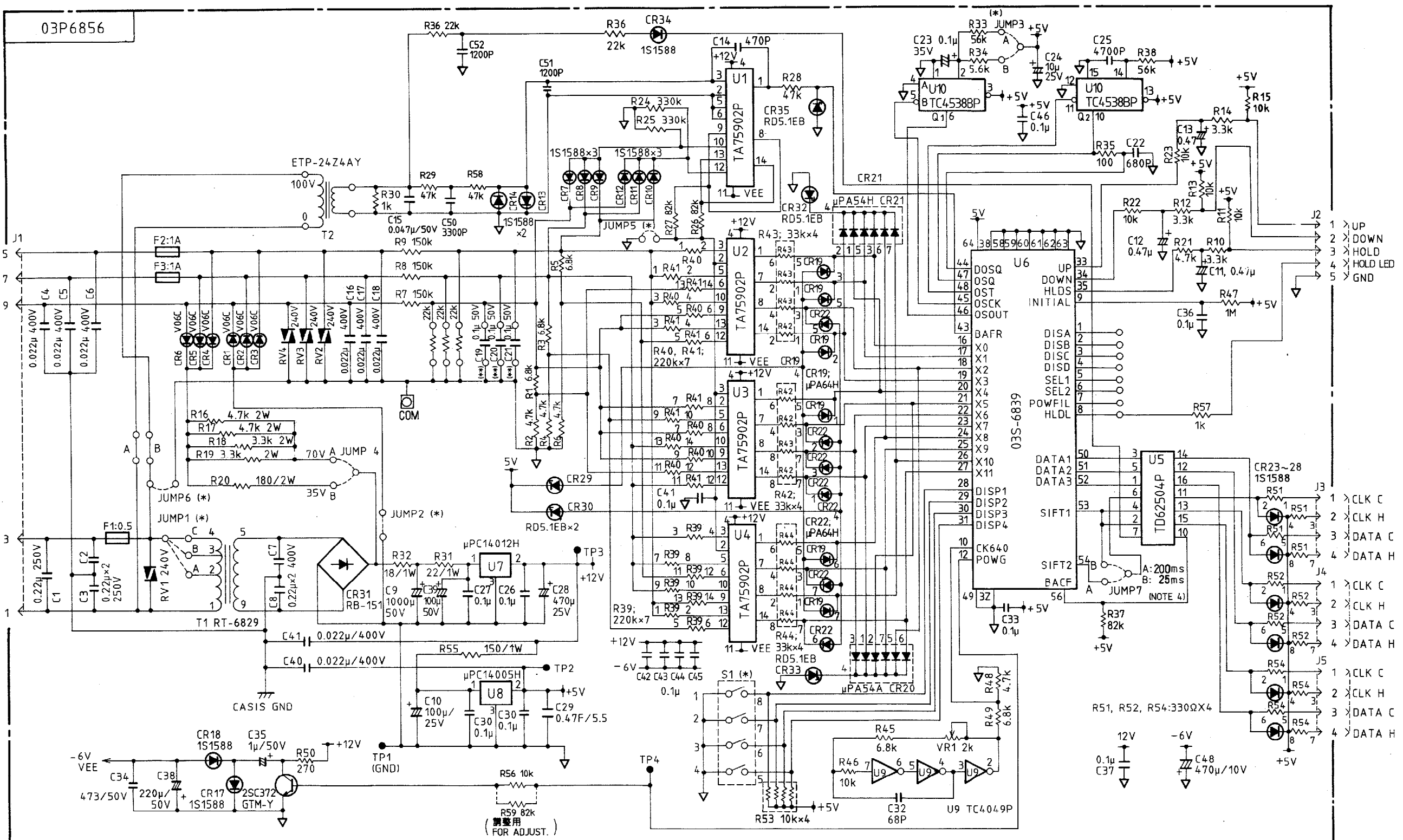
NOTE

- 1. 特記なき抵抗の単位は全てΩ, 0.25W コンデンサはμF. ALL RESISTANCE IN OHMS, 0.25W AND CAPACITANCE IN MICROFARADS UNLESS NOTED OTHERWISE.
- 2. JA-1は 240cm 輻射器の時のみSC-SM接続. その他の場合はSC-INV接続. JA1 MUST BE CONNECTED AS FOLLOWS. FOR 240cm RADIATOR : SC-SM FOR OTHERS : SC-INV



承認 APPROVED	SEP-4-87 T. UAKAWA	名称 TITLE	電源部 (DC入力用) POWER SUPPLY CKT
検図 CHECKED	SEP-4-87 T. UAKAWA		整流部 RECTIFIER CKT
製図 DRAWN	SEP-4-87 I. Amano	図番 DWG.NO.	C3308-015-K

FR-2010T/2020T  
FR-2010/2020



NOTE 1: 特記無き抵抗の値は全てΩ, V4W, 又コンデンサはF.  
 ALL RESISTANCE IN OHMS, 1/4W, AND CAPACITANCE IN FARADS UNLESS NOTED OTHERWISE.

NOTE 2: ジャイロのタイプにより右の表の様にジャンパ接続及び  
 (\*) ディップスイッチの設定が変わる。  
 CHANGE THE JUMPER CONNECTIONS AND SETTING OF DIP SWITCH ACCORDING TO TYPE OF GYRO COMPASS. REFER TO TABLES AT RIGHT.

NOTE 3: 工事材料で支給。  
 (\*\*) SUPPLIED FOR INSTALLATION MATERIALS.

JUMPER CONNECTIONS

	REF. VOLTAGE		JUMPER					
	Freq.	Volt	JUMP 1	JUMP 2	JUMP 3	JUMP 4	JUMP 5	JUMP 6
SYNCHRO TYPE	50/60 Hz	25V	○-○ A	OPEN	A ○-○	OPEN	○-○	OPEN
		50V	○-○ B					
		100V	○-○ C					
STEP ☆	EXT POWER (AC)	25V	○-○ A	OPEN	OPEN	OPEN	OPEN	OPEN
		50V	○-○ B					
		100V	○-○ C					
STEP TYPE	EXT POWER (DC)	OPEN						
STEP TYPE	STEP SIG.	35V	OPEN	○-○	OPEN	B ○-○	OPEN	○-○
		70V	OPEN	○-○	OPEN	A ○-○	OPEN	○-○

☆: プラスコモンの場合等で、外部電源を使用する時  
 WITH USING EXTERNAL POWER FOR POSITIVE COMMON TYPE, ETC.

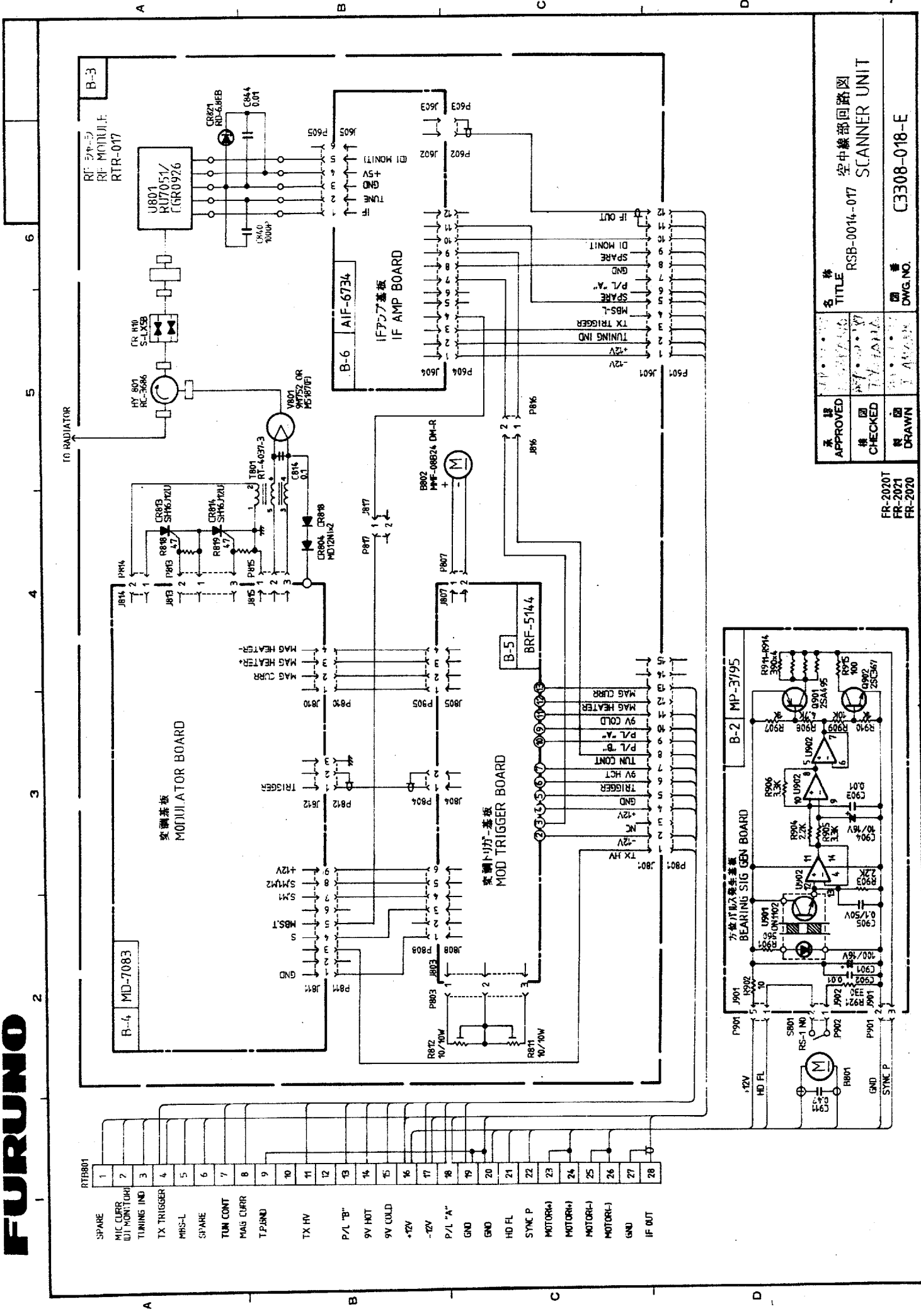
SETTING OF DIP SWITCH

DIP SWITCH	SYNCHRO TYPE						STEP TYPE		
	Freq. (Hz)	50/60			400/500			35	70
	Volt. (V)	25/50/100							
	GYRO RATIO	360X	90X	36X	360X	90X	36X	180X	
DIP SWITCH S1	1	ON	ON	OFF	ON	ON	OFF	ON	
	2	OFF	OFF	OFF	ON	ON	ON	ON	
	3	ON	OFF	OFF	ON	OFF	OFF	ON	
	4	OFF	OFF	OFF	OFF	OFF	OFF	ON	

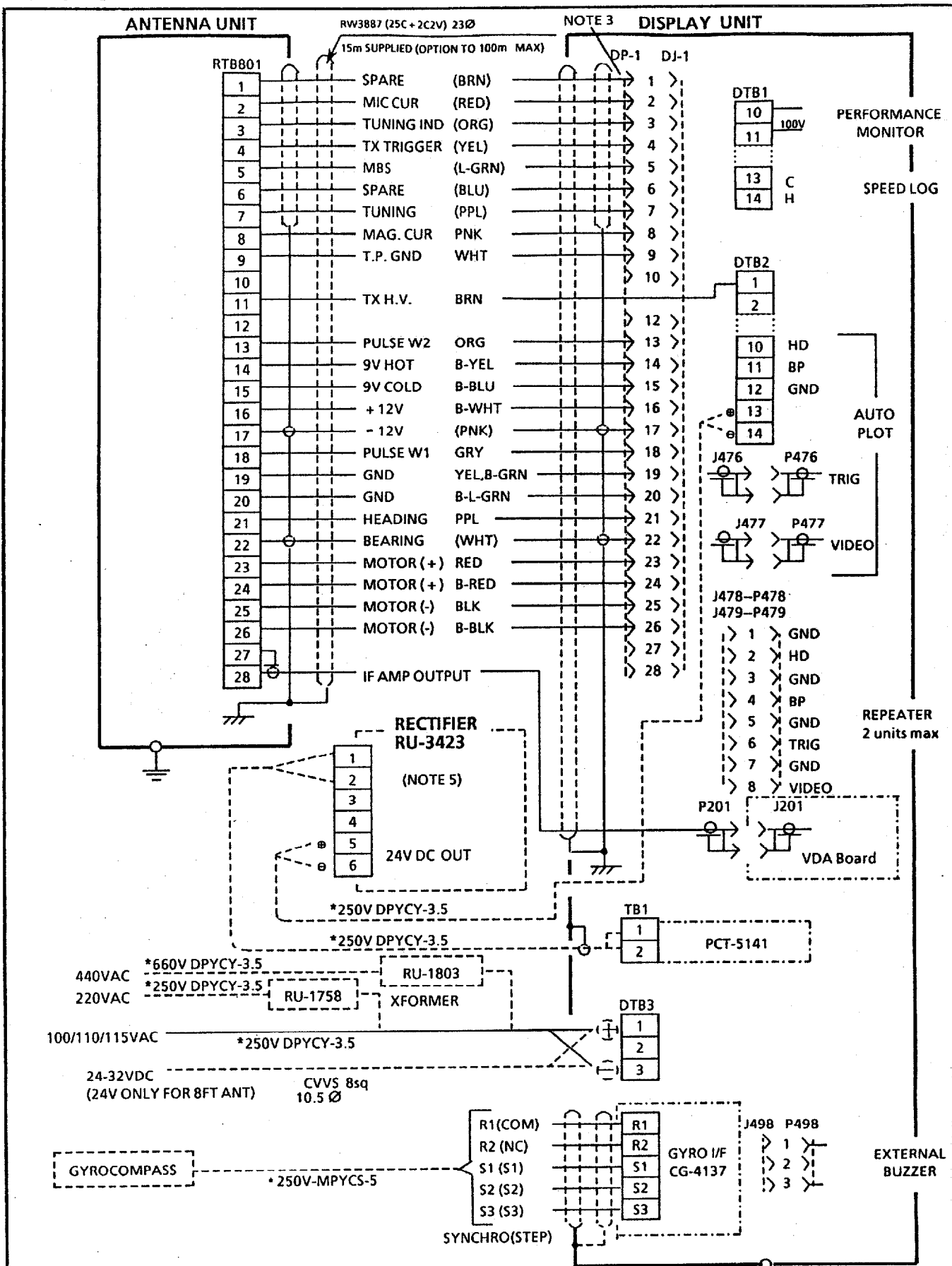
NOTE 4: 出力データ転送周期(J3, J4, J5)  
 OUTPUT DATA TRANSMISSION INTERVAL.  
 J3 -----25msec/200msec  
 ジャンパ線(JUMP7)により切替可  
 SELECTABLE BY JUMP7.  
 J4, J5 ----25msec

GC-1/2/6

承認 APPROVED	MAY 15 '87 T. NAKANO	名称 TITLE	03P6856 (GS-6856)
検閲 CHECKED	MAY 15 '87 I. AMANO		ジャイロインターフェース基板 GYRO INTERFACE P.C.B.
製図 DRAWN	MAY 14 '87 Y. Tomiyama	図番 DWG. NO.	C3307-009-H



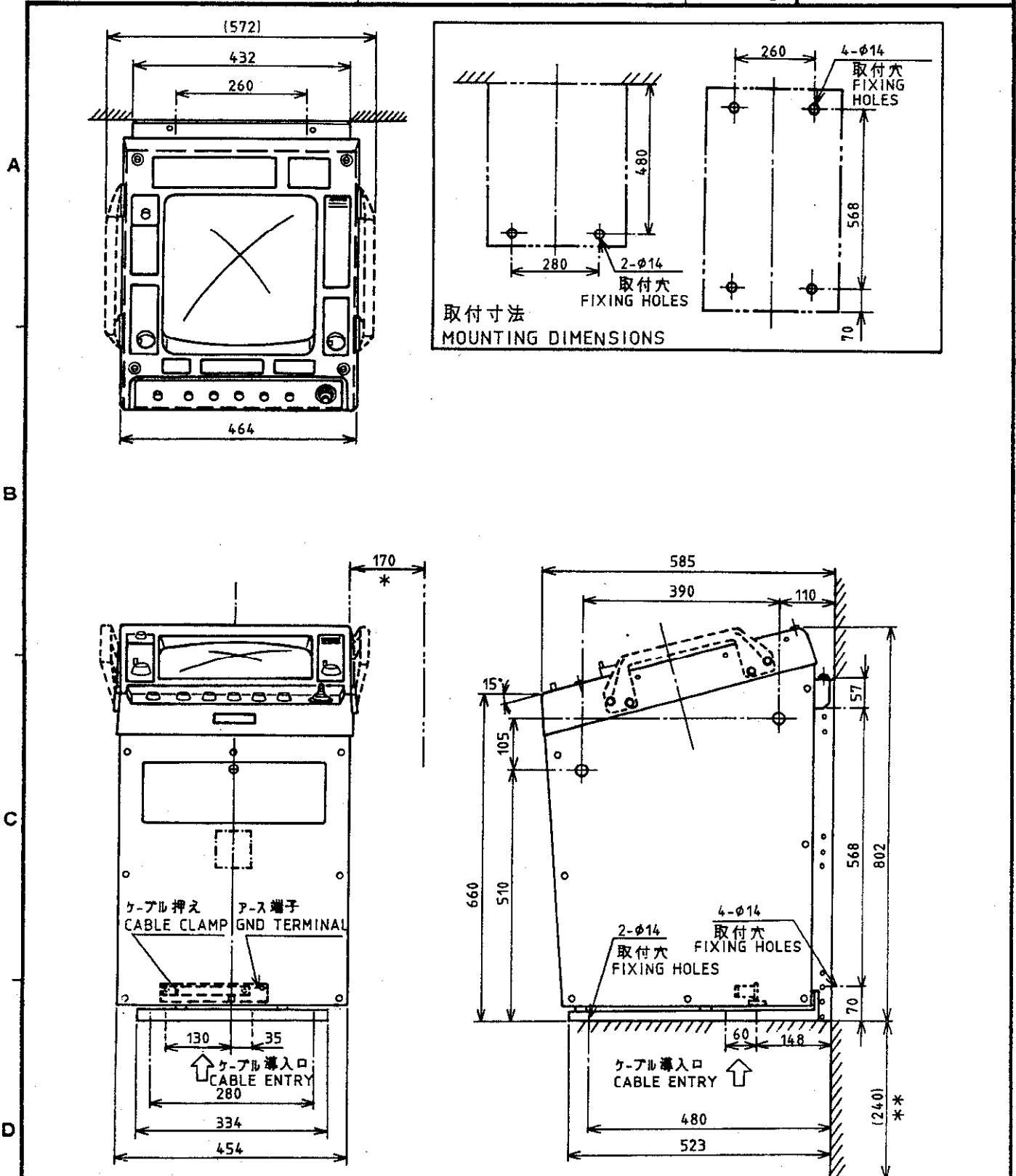
承認 APPROVED	検閲 CHECKED	製図 DRAWN	名 名	種 種	図 圖	番 番
			RSB-0014-017	空中線部回路図	SCANNER UNIT	C3308-018-E
FR-2020T	FR-2021	FR-2020				



NOTE:

1. WIRE COLOR CODE ( ): INSIDE WIRE  
B-: BIG WIRE L-: LIGHT COLOR
2. SHIELD WIRE SHOULD BE EFFECTIVELY GROUNDING AT BOTH ENDS
3. CONNECTOR PLUG FACTORY-WIRED.
4. CABLES AND PARTS MARKED \* ARE NOT SUPPLIED, AND SHOULD BE ARRANGED LOCALLY OR AT SHIPYARD.
5. ONLY FOR 8 FT ANTENNA ON AC MAINS

APPROVED <i>Aug. 6, '87</i> <b>T. NAKANO</b>	TITLE
CHECKED <i>Aug. 6 '87</i> <b>I. Amano</b>	<b>FR-2000 SERIES INTERCONNECTION DIAGRAM</b>
DRAWN	DWG. NO. <b>E 3 3 0 8 - 0 1 2 - B</b>



\*推奨サービス空間  
RECOMMENDED SERVICING CLEARANCE

\*\*推奨高さ  
RECOMMENDED HEIGHT

FR-2000 (S&T)

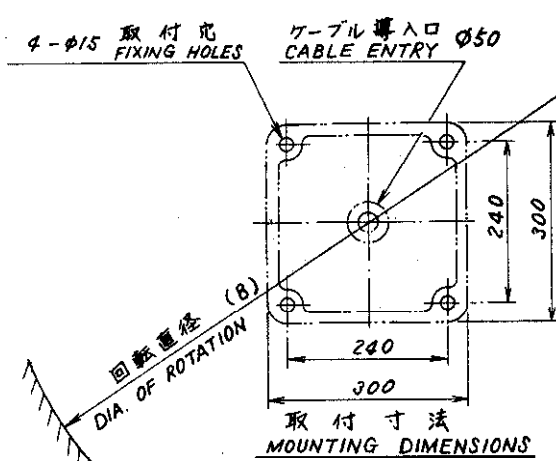
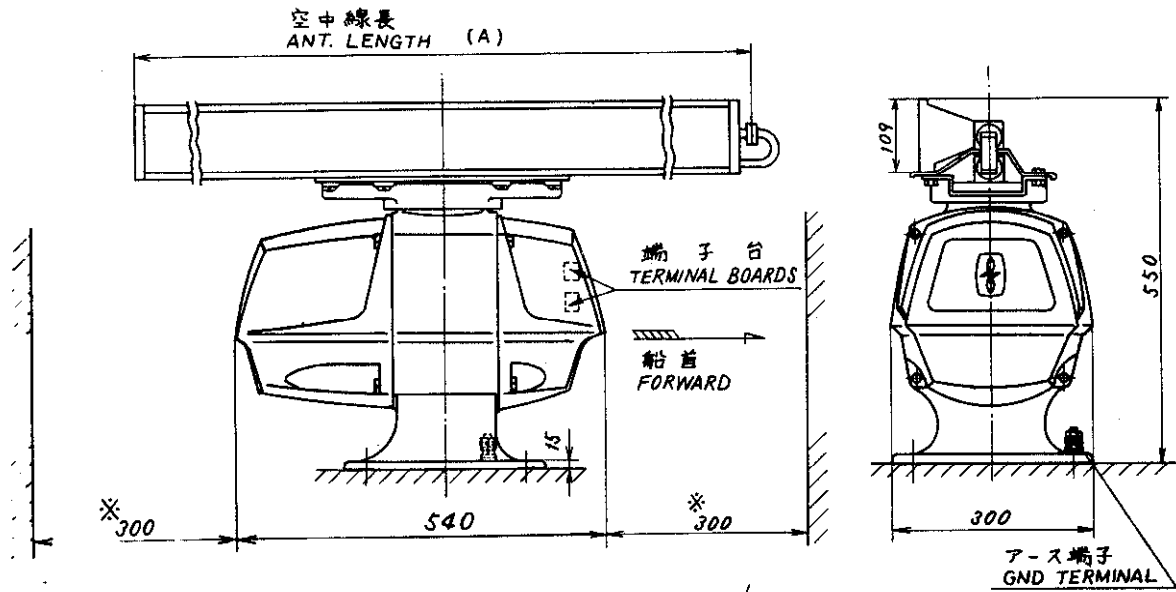
承認 APPROVED	品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS
July 17 '87 I. Amano		三角法 THIRD ANGLE PROJECTION				レ-タ-指示部外寸図 RADAR DISPLAY UNIT
17.6.87		尺度 SCALE				
		重量 WEIGHT	65 kg		図番 DWG.NO. C3308-009-D	

A

B

C

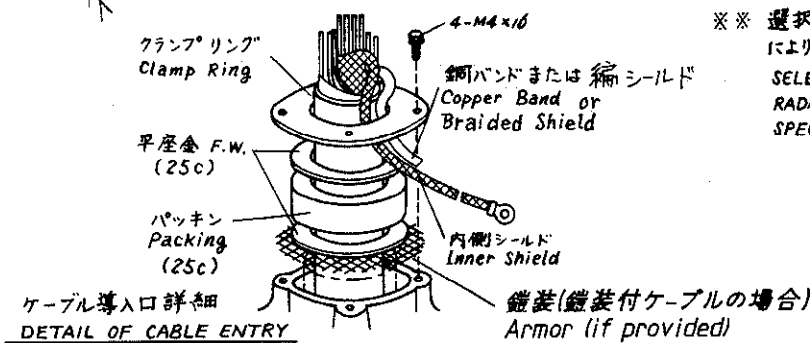
D



NOTE 1. ※: 推奨サービス空間 RECOMMENDED SERVICING CLEARANCE.

NOTE 2.

種類※※ ANT. TYPE	123cm 型 TYPE	200cm 型 TYPE
空中線長 (A) ANT. LENGTH	1250mm	2000mm
回転直径 DIA. OF (B) ROTATION	1400mm	2200mm
重量 WEIGHT	35kg	40kg



※※ 選択可能な空中線部種類は、レーダー型式により異なる。各仕様を参照のこと。  
SELECTABLE ANTENNA TYPE DEPENDS ON RADAR MODEL. SEE INDIVIDUAL SPECIFICATIONS.

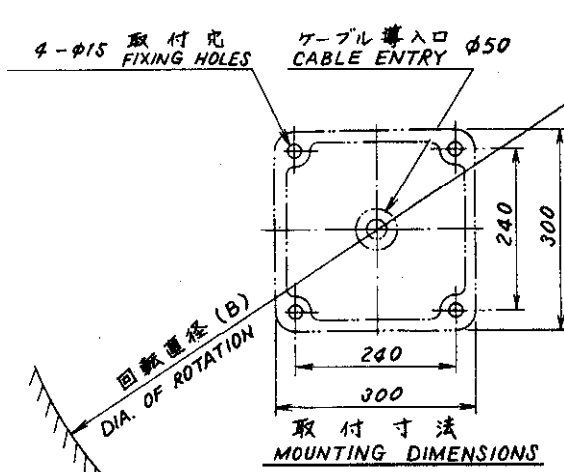
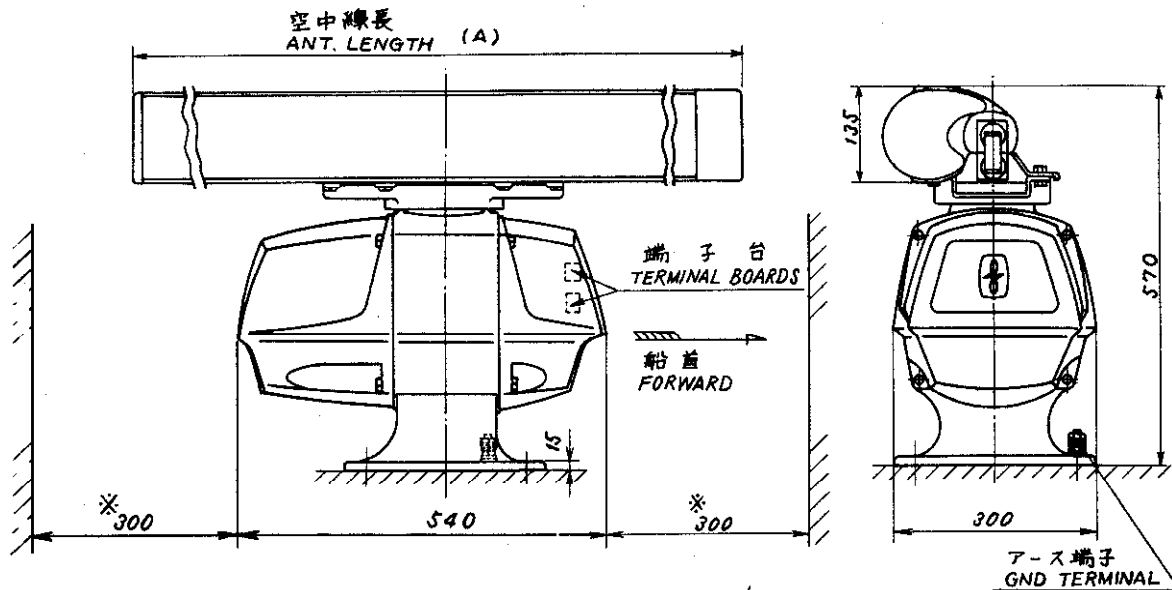
品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG. NO.	摘要 REMARKS
承認 APPROVED	三角法 THIRD ANGLE PROJECTION				名称 TITLE レーダー-空中線部外觀図 RADAR SCANNER UNIT XN2/3-RSB-0014
検図 CHECKED	尺度 SCALE				
製図 DRAWN	重量 WEIGHT	kg		図番 DWG. NO. C3290-004-F	

A

B

C

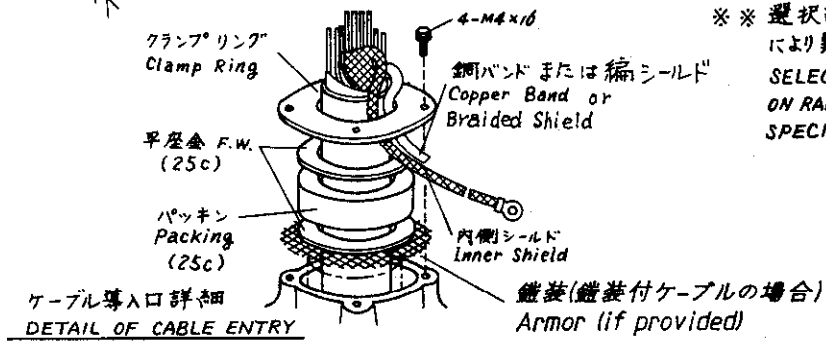
D



NOTE 1. ※: 推奨サービス空間  
RECOMMENDED SERVICING CLEARANCE.

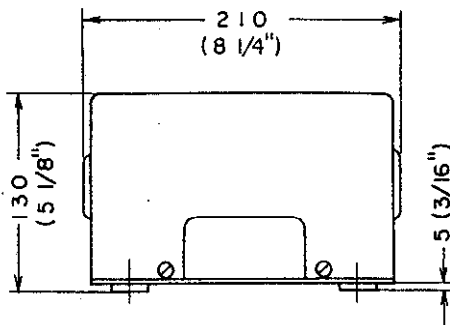
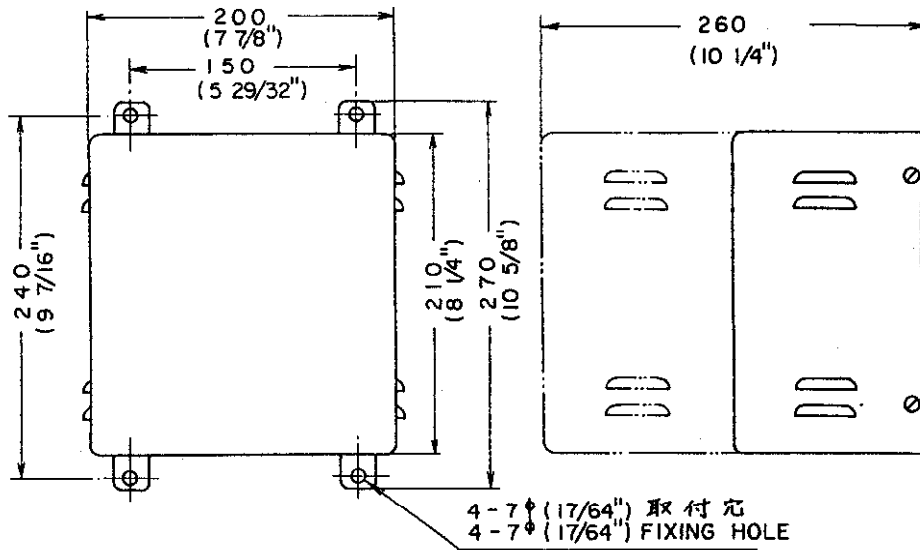
NOTE 2.

種類 ANT. TYPE	200cm型TYPE (XN-3A)	240cm型TYPE (XN-4A)
空中線長 ANT. LENGTH (A)	2070mm	2570mm
回転直径 DIA. OF ROTATION (B)	2200mm	2700mm
重量 WEIGHT	39kg	42kg

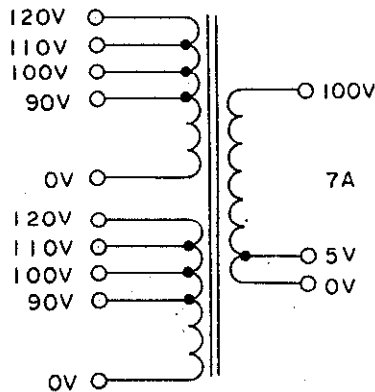


※※ 選択可能な空中線部種類は、レーダー型式により異なる。各仕様を参照のこと。  
SELECTABLE ANTENNA TYPE DEPENDS ON RADAR MODEL. SEE INDIVIDUAL SPECIFICATIONS.

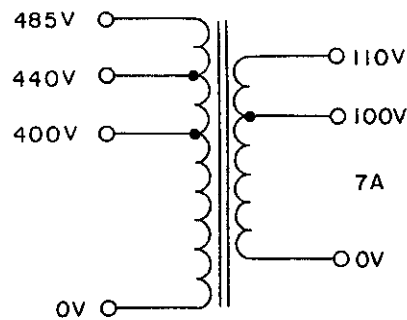
品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG. NO.	摘要 REMARKS
承認 APPROVED	MAR. 4 '86	三角法 THIRD ANGLE PROJECTION	名称 TITLE	レーダー-空中線部外觀図 RADAR SCANNER UNIT XN3A/4A-RSB-0014	
検図 CHECKED	MAR. 4 '86	尺度 SCALE	図番 DWG. NO.	C3290-003-F	
製図 DRAWN	MAR. 4 '86	重量 WEIGHT	kg		



重量 WEIGHT: 12kg (27 lbs)  
単位 UNIT: mm (inches)



AC220V



AC440V

コンパス安全距離 COMPAS SAFE DISTANCE

スタンダード STANDARD	2.1 M
ステアリング STEERING	1.5 M

型式 TYPE	ユニットコード NO.	入力 INPUT	出力 OUTPUT
RU-1758	FC-30416	AC220V	AC100V
RU-1803	FC-30417	AC440V	AC100V

Date Sept., 1974

Checked

Ref.

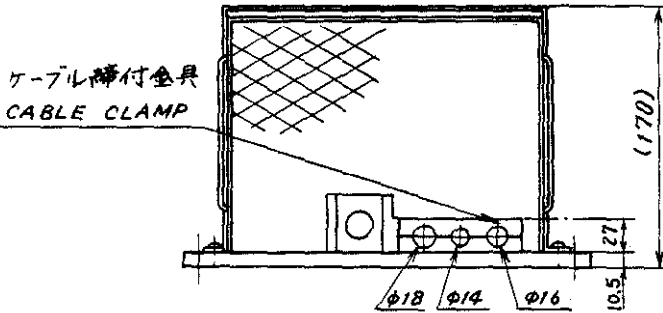
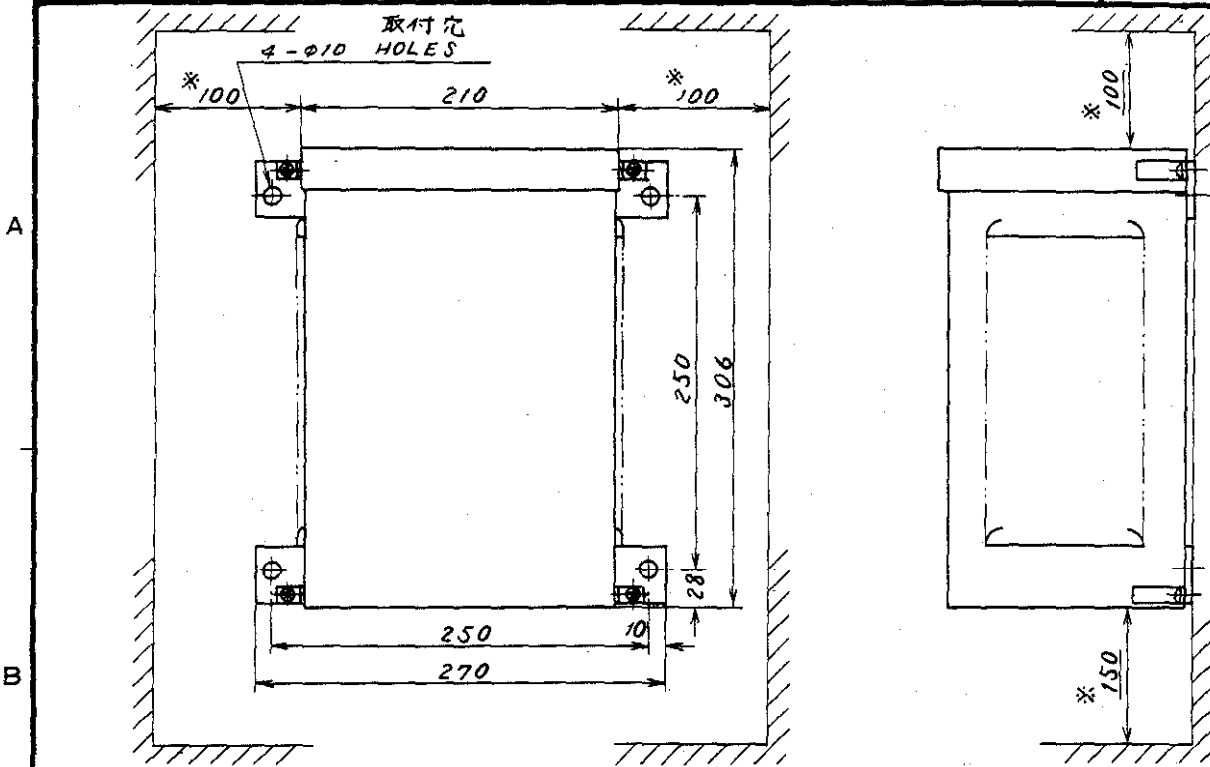
TITLE

RU-1758/1803 トランス ユニット  
TRANSFORMER UNIT

DWG. No. C3003-001-B

**FURUNO ELECTRIC CO., LTD.**

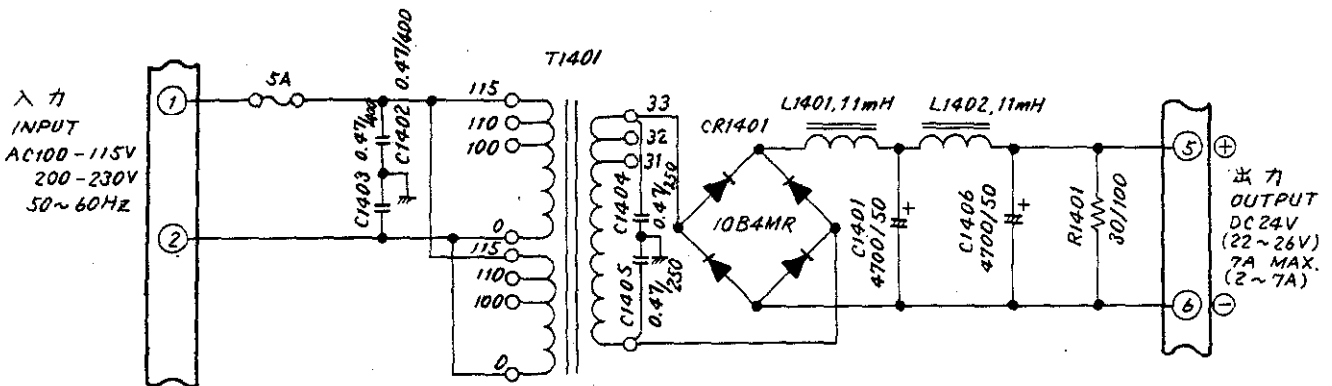




NOTE 1. ※: 推奨サービス空間。  
RECOMMENDED SERVICING CLEARANCE.

2. コンパス安全距離  
COMPASS SAFE DISTANCE.

スタンダード STANDARD	2.1M
ステアリング STEERING	1.5M



注 AC220V 入力に対しては T1401 の一次巻線と直列に接続する。

NOTE FOR 220VAC INPUT, CONNECT T1401 PRIMARY WINDINGS IN SERIES.

承認 APPROVED	品番 ITEM	品名 NAME	材質 MATERIAL	数量 Q'TY	図番 DWG.NO.	摘要 REMARKS
JAN 18 '79		三角法 THIRD ANGLE PROJECTION				名称 TITLE RU-3423 整流器 RECTIFIER UNIT
JAN 17 '79		尺度 SCALE 1/5				
JAN 16 '79		重量 WEIGHT 16.5kg			図番 DWG.NO. C3002-005-H	

REV.: 8/85

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